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Alliance Technologies Corp., Chapel Hill, NC

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PROCEDURES FOR THE PREPARATION OF EMISSION INVENTORIES FOR PRECURSORS OF OZONE

VOLUME I

THIRD EDITION

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16. ABSTRACT

Procedures are described for compiling emission inventories of precursors of ozone (volatile organic compounds, nitrogen oxides and carbon monoxide) for use in less data-intensive models such as the Empirical Kinetic Modeling Approach (EKMA). Such inventories are required for submission of ozone State Implementation Plans (SIPs) for those areas required to revise their plans after December 31, 1987.

The basic inventory elements - planning, data collection, emission inventory estimates, reporting - are discussed. Various examples are included to aid the agency in the understanding and use of this document.

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a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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EKMA	Modeling		
Precursors	Nitrogen Oxides		
Volatile organics	Carbon Monoxide		
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VOLUME I

THIRD EDITION

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OFFICE OF AIR QUALITY PLANNING AND STANDARDS
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PREFACE

The purpose of this document is to provide assistance to personnel of air pollution control agencies in preparing and maintaining emission inventories for precursors of ozone. Inventories are often routinely used in the conduct of air quality programs. For example, EPA's requirements for ozone State Implementation Plans (SIPs) include an updated inventory of emissions of volatile organic compounds (VOC), nitrogen oxides (NO_x), and carbon monoxide (CO).

This document has been revised from the 1980 version to include current information pertinent to the inventorying of emissions of precursors of ozone. This edition includes changes and additions as briefly summarized below:

- Reflects emission inventory requirements for post-1987 ozone SIPs.
- Develops surrogates that state/local agencies can use to identify sources traditionally considered as area sources that are likely to emit greater than 25 TPY and greater than 10 TPY VOC in Section 3.0.
- Provides guidance for estimating emissions for facilities that run batch or intermittent precesses in Section 3.1.
- Includes new information in Section 4.4 on inventorying emissions from publicly owned treatment works (POTW), hazardous waste treatment, storage, and disposal facilities (TSDF), industrial wastewater treatment plants, leaking underground storage tanks, and municipal landfills.
- Expands discussion on quality assurance (QA) techniques and procedures, including checkpoints, checklists, and reasonable data ranges, in Section 5.0.
- Includes examples of emission estimations in Section 6.0.
- Discusses seasonal variations and adjustments in emissions, develops seasonal adjustment factors for area source categories, and includes guidance for adjusting the emissions for a typical summer day in Section 6.0.
- Updates and expands list of emission sources including processes/operations within source categories and updates example format and data elements for inventorying point sources for ozone SIP emission inventories in Appendix B.
- Includes new information in Appendix C on Group III Control Techniques Guidelines (CTG).

- Updates discussions of associated EPA programs and references pertinent to inventorying.

- Includes guidance where appropriate to address VOC, NO_x, and CO, but with focus on VOC.

1.0 INTRODUCTION

1.1 PURPOSE

Ozone is photochemically produced in the atmosphere when volatile organic compounds (VOC) are mixed with nitrogen oxides (NO_x) and carbon monoxide (CO) in the presence of sunlight. In order for an air pollution control agency to develop and implement an effective ozone control strategy, information must be compiled on the important sources of these precursor pollutants. This is the role of the emission inventory--to tell the agency what types of sources are present in an area, how much of each pollutant is emitted, and what types of processes and control devices are employed at each plant. Prior to development of an ozone control strategy, the inventory must be used with an appropriate source/receptor model to relate emissions of VOC, NO_x, and CO to subsequent levels of ozone in the ambient air.

Emission inventories are compiled with the aid of methodologies which are described in inventory guideline references. One such reference, Procedures for Emission Inventory Preparation, Volumes I-V,[1] was developed as general guidance to those engaged in inventorying criteria pollutants.

This document, published in two volumes, provides guidance to those engaged in the planning and compilation of ozone precursor emission inventories (VOC, NO_x, and CO). Volume I is devoted to presenting step by step procedures for compiling the basic emission inventory. In this context, "basic" refers to an inventory that provides the type of data needed for the simplest photochemical ozone source/receptor models, such as the Empirical Kinetic Modeling Approach (EKMA).[2,3] Generally, the basic inventory will produce annual or seasonal emission estimates of reactive VOC, NO_x, and CO for relatively large areas. Spatial resolution in such an inventory will be at the county, township, or equivalent level. This volume (Volume I) outlines the procedures that an agency should consider in compiling an emission inventory when not anticipating use of a photochemical atmospheric simulation model. While the emphasis of this document is on methods for preparing emission inventories for VOC, the bulk of these methods are appropriate for preparation of emission inventories for NO_x and CO. Differences in methods and considerations are noted where they exist.

Volume II describes techniques for compiling inventories of hourly emissions allocated to subcounty grids.[4] Reactive VOC and NO_x in such inventories are allocated into various classes or species categories. Such degree of detail is required so that the inventory can be input to various photochemical atmospheric simulation models.

Volume I contains a set of general technical procedures rather than a single prescriptive guideline for completing an emission inventory. Because users' needs may vary from area to area, and because certain techniques may be applicable in some areas and not in others, a number of optional techniques representing various levels of detail are presented for certain source categories. In addition, advantages and disadvantages of these techniques are weighed to help the agency decide what level of detail will be sufficient to

meet its needs and objectives and, at the same time, what can be accomplished given the constraints on the inventory compilation effort.

This document is not intended to set forth the Environmental Protection Agency's requirements for inventory development or inventory data submittals. Those requirements are defined elsewhere.[5] Moreover, this document does not prescribe what control measures should be considered in a specific inventory effort such as Reasonably Available Control Technology (RACT). Although these topics are mentioned in Volume I for discussion and example purposes, the reader should consult the Environmental Protection Agency's State Implementation Plan (SIP) regulations to determine the specific emission inventory and control strategy requirements applicable to particular programs.

1.2 CONTENTS OF VOLUME I

The emphasis of this document is on the development of VOC, NO_x, and CO emission inventories that are useful in various facets of an ozone control program. Thus, the bulk of the discussion on the planning and implementation of an inventory centers on issues that relate to developing a strategy for ozone control. These inventories can, of course, be useful to the agency in other areas, such as in programs dealing with specific toxic organic chemicals. The procedures in this document will be generally applicable to the development of VOC emission inventories for use in other program areas and for other pollutants.

Volume I is divided into chapters that correspond to the major steps necessary in the basic inventory effort. Chapter 2 discusses planning, an important and often neglected aspect of inventory effort. Chapter 3 describes the various ways source and emissions data can be collected on individual sources for use in the point source inventory. Chapter 4 describes area source estimating procedures for making collective activity level and emission estimates for those sources generally too small or too numerous to be considered individually in the point source inventory. Chapter 5 describes quality assurance procedures that can be used during each phase of the emission inventory process including planning, data collection, and data reporting. Chapter 6 discusses procedures for making emission estimates based on the source data collected from the plant contacts, field surveys, and questionnaires. Chapter 7 discusses reporting, i,e., the presentation of inventory information in various ways useful to the agency.

Appendix A contains a glossary of important terms used in conjunction with emission inventories. Appendix B provides a detailed listing of point source process emission points. Appendix C contains summary descriptions of the VOC sources for which EPA has already established or will establish control techniques guidelines (CTG). Appendix D includes an example of a cover letter and questionnaire used in mailing surveys for point source inventories.

Comments and suggestions regarding the general technical content of this document should be brought to the attention of E. L. Martinez, MD-14, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

References for Chapter 1.0

1. Procedures for Emission Inventory Preparation, Volumes I-V, EPA-450/4-81-026, a-e, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1981.

2. Uses, Limitations and Technical Basis of Procedures for Quantifying Relationships Between Photochemical Oxidants and Precursors, EPA-450/2-77-021a, U.S. Environmental Protection Agency, Research Triangle Park, NC, November 1977.

3. User's Manual for OZIP M-4 Ozone Isopleth Plotting with Optional Mechanisms/Version 4, Draft, U.S. Environmental Protection Agency, Research Triangle Park, NC, November 1987.

4. Procedures for the Preparation of Emission Inventories for Volatile Organic Compounds, Volume II, EPA-450/4-79-018, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1979.

5. Emission Inventory Requirements for Post-1987 Ozone State Implementation Plans, EPA-450/4-88-019, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1988.

2.0 INVENTORY OVERVIEW AND PLANNING

2.1 OVERVIEW OF INVENTORY PROCEDURES

The next several chapters present the "how to" for compiling the basic emission inventory. Emphasis is given to methodologies that produce emission estimates for broad geographical areas and which can be resolved to the county level. Some discussion is devoted to adjusting an annual inventory of emissions to reflect conditions during the ozone season, which is the time interval of primary interest in photochemical ozone production.

Four basic steps are involved in the preparation of an emission inventory. The first is planning. The agency should define the need for the inventory as well as the constraints that limit the ability of the agency to produce it. The various planning aspects discussed in the following sections of this chapter should all be considered prior to initiation of the actual data gathering phases of the inventory effort. All proposed procedures and data sources should be documented at the outset and be subjected to review by all potential users of the final inventory, including the management and technical staff of the inventory agency.

The second basic step is data collection. A major distinction involves which sources should be considered point sources in the inventory and which should be considered area sources. Fundamentally different data collection procedures are used for these two source types. Individual plant contacts are used to collect point source data, whereas collective information is generally used to estimate area source activity. Much more detailed data are collected and maintained on point sources.

The third basic step in the inventory compilation effort involves an analysis of data collected and the development of emission estimates for each source. Emissions will be determined individually for each point source, whereas emissions will generally be determined collectively for each area source category. Source test data, material balances, and emission factors are all used to make these estimates. Adjustments are necessary if the VOC inventory is to reflect only reactive VOC and if the resulting emission totals are to be representative of the ozone season. A special adjustment called "scaling up" is necessary in some cases to account for sources not covered in the point source inventory. Estimates of projected emissions would be made as part of this step.

The fourth step is reporting. Basically, reporting involves presenting the inventory data in a format that serves the agency in the development and implementation of an ozone control program or other regulatory effort. Depending on the capabilities of the inventory data handling system, many kinds of reports can be developed that will be useful in numerous facets of the agency's ozone control effort.

2.2 GENERAL PLANNING CONSIDERATIONS

Before an agency initiates the actual compilation of the emission inventory, the agency's management and technical staff must determine the specific inventory needs with respect to ozone strategy development and must define the inventory objectives. A number of other items must also be considered before the inventory is actually initiated. These considerations involve technical, economic, and legal requirements and constraints. The time and resources expended in dealing with these various requirements and constraints will vary depending on the agency's needs. This chapter provides guidance to help agency management and technical staff decide how these various considerations can best be addressed with resources available to design and complete the emission inventory.

During the planning step of the emission inventory, the agency should address a number of questions which occur in developing the inventory. The following questions should be answered prior to initiating the collection phase of the inventory effort.

- Has the point source cutoff level been defined? What level of resolution will be needed in the area source inventory to account for the large number of various industrial/commercial solvent users that exist whose emissions are below the chosen point source cutoff level?

- How will source data be collected for point and area sources?

- What procedures will be used to obtain data from sources to identify nonreactive VOC emissions and exclude them from the inventory?

- Will emission projections be needed? What data will the agency need to project emissions? Will general growth factors be used, or will facility-specific growth information be solicited during the plant contacts? Will the procedures used for estimating projected emissions be methodologically consistent with those in the base year? What will be the projection period, including the end year and intermediate years?

- Will inventory be projected based on actual or allowable emissions?

- What are the end uses of the emission inventory (i.e., State Implementation Plan [SIP] submittal, toxic emission inventory development, community or constituency reports, air quality studies, etc.)?

- What point and area source categories will be included in the inventory? Are these categories compatible with the source and emissions information available? Are they detailed enough to facilitate making control strategy projections, to readily define emissions of nonreactive VOC, and to use photochemical air quality emission models if appropriate?

- What manpower and budget allocations are required and available for the inventory effort?

o Has the geographical area that will be inventoried been outlined? What level of spatial resolution is needed for the source/receptor model that will be used? What are the smallest political jurisdictions within the inventory area for which area source activity level information is readily available?

o Is the inventory base year appropriate for the inventory end use? What year has been selected?

o What sources will have seasonally varying emissions and what information will be needed to estimate emissions during the ozone season? Will annual or daily emissions be compiled? Will rule effectiveness be applied? Will rule effectiveness be determined for each category or will rule effectiveness be applied uniformly?

o Can an existing inventory (including background data) be used as a starting point for the update? Are important VOC, NO_x, or CO sources omitted from the existing data base?

o Is the inventory to be used in ozone modeling? If so, is a NO_x and/or CO inventory also needed? If so, are all sources of NO_x and/or CO identified, including those noncombustion industrial processes that do not emit any VOC?

o What inventory data handling system will be utilized? Is it compatible with other appropriate systems?

o What quality control and assurance measures are to be applied to the emissions inventory?

o What inventory documentation will be required?

o Does the agency anticipate running a photochemical model using the basic inventory as a starting point for a more resolved inventory? If so, has Volume II[1] been reviewed so that the additional data needs and data handling requirements can be considered in the planning stages?

The subject of each of the above questions is discussed briefly in the next sections.

2.2.1 EMISSION INVENTORY END USES

The most basic consideration in inventory planning is the ultimate use(s) of the emission inventory. The end uses of an inventory fall into two general categories: (1) air quality studies and (2) air quality control strategy development.

An air quality studies inventory could fulfill any number of data requirements for understanding the relationship between VOC, NO_x, and CO emissions and ozone concentrations in any given study area. Usually, inventory requirements are determined only by the inventory agency's study needs. Thus,

most study area inventories are unrestricted, allowing the agency unlimited consideration of inventory methodologies, data reporting formats, projection techniques, and the other items discussed in the remaining sections of this chapter.

While air quality or emission control strategy inventories can be initiated by an individual agency, most inventories are undertaken in response to legal requirements which usually include specific procedures to be used. The most commonly required inventory is the SIP inventory. Requirements for these inventories are outlined in EPA guidance before the SIP submittals are to be completed.

In addition to fulfilling legal requirements, a good VOC control strategy inventory can be very useful to an air pollution agency. On a day-to-day basis, the point source listing of the inventory can be useful in investigating citizen complaints and possible violations of emission codes. In the long term, an accurate compilation of emissions in the inventory will lead to better assessment of the impact of community growth on air quality. The inventory can achieve a number of program objectives, whether investigative or regulatory in nature.

2.2.2 DEFINITION OF VOC

EPA defines VOC as "any organic compound which participates in atmospheric photochemical reactions; or which is measured by a reference test method" (40 CFR, Part 60.2). These organics include all carbonaceous compounds except carbonates, metallic carbides, CO, CO_2, and carbonic acid. No clear demarcation between volatile and non-volatile organics exists; however, organics which evaporate rapidly at ambient temperatures contribute the predominant fraction to the atmospheric burden.

A few VOCs have been exempted from control strategies under ozone SIPs because of their negligibly low photochemical reactivity. These exempt compounds are discussed in 2.2.11.

A complete discussion of the nomenclature of organic compounds is beyond the scope of this work, although a brief mention of some of the more common generic names may be beneficial. Most common aromatic compounds contain a benzene ring, which is a six carbon ring with the equivalent of three double bonds in a resonant structure. If the compound is not aromatic, it is said to be aliphatic. Aliphatic hydrocarbons include both saturated and unsaturated compounds. Saturated compounds have all single bonds. Unsaturated compounds have one or more double or triple bonds. Halogenated compounds contain chlorine, fluorine, bromine, or iodine. Alcohols and phenols contain a hydroxyl group (-OH). Ketones and aldehydes contain a carbonyl group ($>C=O$). Acids contain a carboxylic acid group ($-C\overset{O}{\leq}_{OH}$). Esters resemble carboxylic acids, having an organic radical, R, substituted for hydrogen ($-C\overset{O}{\leq}_{OR}$).

2.2.3 SOURCES OF VOC EMISSIONS

An important consideration affecting the emission inventory is whether all sources of VOC are included in the inventory. Table 2.2-1 presents those major sources of VOC that should be considered in the inventory. Some sources in this table are usually considered point sources, some are usually handled collectively as area sources, while others, such as dry cleaners, can be either point or area sources, depending on the size of each operation and the particular cutoff made between point and area sources.

The entries in Table 2.2-1 include general source categories but not all of the emitting points that may be associated with any of the particular source categories. For example, petroleum refining operations actually include many emitting points ranging from process heaters to individual seals and pumps. Table B-1 in Appendix B contains a more detailed listing of processes included in the categories shown in Table 2.2-1. General process and emissions information on these sources may be obtained from AP-42, Compilation of Air Pollution Emission Factors[2] (including supplements) and in Appendix C of this document.

Those stationary sources of VOC for which EPA has published Control Techniques Guidelines (CTG) are included in the categories listed in Table 2.2-1 and Appendix B. Summary information on many of these sources is presented in Appendix C. Additional process, emission, and control device information is available on these sources in the CTG documents which are available from the Director, Emission Standards Division, MD-13, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. Many of these documents are cited in the following chapters and in Appendix C of this volume.

2.2.4 EMISSION INVENTORY MANPOWER REQUIREMENTS

Cost and manpower requirements should be evaluated in the planning stage of the emission inventory project. Technical manpower and budget allocations required will be a function of the number and type of sources to be inventoried, the pollutants being inventoried, and the desired data base detail. These inputs, in turn, will be affected by the inventory end use, the size of the inventory area, and the agency's data handling capabilities. Administrative and secretarial support will be a function of the technical manpower and budget allocations determined by all of the above factors.

2.2.5 GEOGRAPHICAL AREA

The responsible agency must determine geographical boundaries within which emissions will be inventoried. Statewide inventories provide a broad comprehensive data base which can be useful but which requires increased data handling. The basis for deciding the area to be inventoried should include meteorological and air quality data as well as control strategy considerations.

TABLE 2.2-1. VOC, CO AND NO_x EMISSION SOURCES

SOURCES OF EMISSIONS	POLLUTANTS		
	VOC	CO	NO_x
Storage, Transportation, and Marketing of Petroleum Products and Volatile Organic Liquids			
Oil and Gas Production	X		
Petroleum Product and Crude Oil Storage	X		
Bulk Terminals	X		
Bulk Plants	X		
Volatile Organic Liquid Storage and Transfer	X		
Vessels	X		
Barge, Tanker, Tank Truck and Rail Car Cleaning	X		
Barges, Tankers, Tank Trucks and Rail Cars in Transit	X		
Service Station Loading (Stage I)	X		
Service Station Loading (Stage II)	X		
Formulation and Packing VOL for Market	X		
Local Storage (airports, industries that use fuels, solvents and reactants in their operation).	X		
Industrial Processes			
Petroleum Refineries	X	X	X
Natural Gas and Petroleum Product Processing	X	X	X
Lube Oil Manufacture	X	X	X
Organic Chemical Manufacture	X	X	X
Inorganic Chemical Manufacture	X	X	X
Iron & Steel Production	X	X	X
Coke Production	X	X	X
Coke By-Product Plants	X	X	X
Synthetic Fiber Manufacture	X		
Polymers and Resins Manufacture	X		
Plastic Products Manufacture	X		
Fermentation Processes	X		
Vegitable Oil Processing	X		
Pharmaceutical Manufacturing	X		
Rubber Tire Manufacture	X		
SBR Rubber Manufacture	X		
Ammonia Production	X		
Carbon Black Manufacture	X	X	X
Phthalic Anhydride Production	X		
Terephthalic Acid Production	X		
Maleic Anhydride Production	X		

TABLE 2.2-1. VOC, CO AND NO_x EMISSION SOURCES (Continued)

SOURCES OF EMISSIONS	POLLUTANTS		
	VOC	CO	NO_x
Industrial Processes (Continued)			
Pulp and Paper Mills	X	X	X
Primary and Secondary Metals Production	X	X	X
Plywood, Particle Board, Pulp Board, Chip or Flake Wood Board	X		
Charcoal Production	X	X	X
Carbon Electrode and Graphite Production	X		
Paint, Varnish and Other Coatings Production	X		
Adhesives Production	X		
Printing Ink Manufacture	X		
Scrap Metals Clean Up	X		
Adipic Acid Proction	X		X
Coffee Roasting	X		X
Grain Elevators (fumigation)	X		
Meat Smokehouses	X	X	X
Asphalt Roofing Manufacture	X	X	X
Bakeries	X		
Fabric, Thread and Fiber Dying and Finishing	X		
Glass Fiber Manufacture	X		
Glass Manufacture	X	X	X
Soaps, Detergents and Cleaning Agents Manufacturing, Formulation and Packaging	X		
Food and Animal Feedstuff Processing and Preparation	X		
Bricks and Related Clays		X	X
Industrial Surface Coating			
	X		
Large Appliances	X		
Magnet Wire	X		
Autos and Light Trucks	X		
Cans	X		
Metal Coils	X		
Paper/Fabric	X		
Wood Furniture	X		
Metal Furniture	X		
Miscellaneous Metal Parts and Products	X		
Flatwood Products	X		
Plastic Products	X		
Large Ships	X		
Large Aircraft	X		

TABLE 2.2-1. VOC, CO AND NO_x EMISSION SOURCES (Continued)

SOURCES OF EMISSIONS	POLLUTANTS		
	VOC	CO	NO_x
Nonindustrial Surface Coating			
Architectural Coatings	X		
Auto Refinishing	X		
Other Solvent Use			
Degreasing[a]	X		
Dry Cleaning	X		
Graphic Arts	X		
Adhesives	X		
Solvent Extraction Processes	X		
Cutback Asphalt	X		
Consumer/Commercial Solvent Use	X		
Asphalt Roofing Kettles	X	X	X
Pesticide Application	X		
External Combustion Sources[a]			
Industrial Fuel Combustion	X	X	X
Coal Cleaning	X		X
Electrical Generation	X	X	X
Commercial/Institutional Fuel Combustion	X	X	X
Residential Fuel Combustion	X	X	X
Resource Recovery Facilities	X	X	X
Solid Waste Disposal	X	X	X
Recycle/Recovery (Primary Metals)	X	X	X
Sewage Sludge Incinerators	X	X	X
Stationary Internal Combustion[a]			
Reciprocating Engines	X	X	X
Gas Turbines	X	X	X
Waste Disposal			
Publicly Owned Treatment Works	X		
Industrial Wastewater Treatment	X		
Municipal Landfills	X		
Hazardous Waste Treatment, Storage and Disposal Facilities	X		

TABLE 2.2-1. VOC, CO AND NO_x EMISSION SOURCES (Continued)

SOURCES OF EMISSIONS	POLLUTANTS		
	VOC	CO	NO_x
Mobile Sources			
Highway Vehicles	X	X	X
Nonhighway Vehicles	X	X	X

[a]Emissions from these sources may occur from source categories identified elsewhere in Table 2.2-1. For example, carbon monoxide and oxides of nitrogen are emitted from industrial boilers at organic and inorganic manufacturing facilities. Likewise, carbon monoxide and oxides of nitrogen are emitted from reciprocating engines at oil and gas production facilities, and volatile organic compounds are emitted from many industries involved in degreasing operations. An effort should be made to avoid double counting from these sources.

Because ozone can form as a result of photochemical reactions many miles downwind from the precursor pollutant sources, a fairly broad area should be covered by the emissions inventory. At a minimum, the inventory should encompass the Metropolitan Statistical Area (MSA) or Consolidated Metropolitan Statistical Areas (CMSA) urban and suburban areas. Ideally, the inventory area should include (1) all major emission sources that may affect the urban area, (2) areas of future industrial, commercial, and residential growth, (3) as many ambient pollutant monitoring stations as possible, and (4) downwind receptor sites of interest. In this last regard, the inventory area should encompass areas downwind of the urban area where peak ozone levels occur. In general, the area inventoried for a less data intensive source/receptor model, such as EKMA,[3] should be the same as the area to be covered for use in a photochemical dispersion model.

Modeling considerations are not the only factors influencing the designation of the area covered by the inventory. In many cases, the inventory area will be prescribed to follow certain existing political boundaries. Most commonly, county boundaries are followed. In certain cases, however, other jurisdictions will be considered, such as cities, towns, townships, or parishes. Typically, the inventory area includes a collection of jurisdictions representing air basins or at least areas enduring common air pollution problems.

In cases where the inventory area has not been prescribed, or if uncertainties exist about future land use or the effect of meteorological conditions, the agency should include as much area as possible. In this way, the emission inventory used for modeling and control strategy analyses will include most of the emissions possibly affecting air quality in a given area.

2.2.6 SPATIAL RESOLUTION

Because the less data intensive source/receptor relationships, such as EKMA, are not sensitive to changes in the location of emissions, data compiled at the county (or county equivalent) level generally provide sufficient spatial resolution. The county limits are logical boundaries for compiling an emission data base for two reasons. The first is because of the areawide nature of the ozone problem. Ozone is generally not a localized problem since formation occurs over a period of several hours, or in some cases, days, as a result of reactions among precursor pollutants emitted over broad geographical areas. Consequently, less spatial resolution is usually required for volatile organic emissions than is necessary for other pollutants.

The second reason for compiling volatile organic emission inventories on a county basis is that of data availability. The county represents the smallest basic jurisdiction for which various records appropriate for use in developing area source emission estimates are typically kept. Thus, because it provides sufficient resolution for the less data intensive source/receptor relationships, and because of the convenience it affords the agency, the county is generally the optimum jurisdictional unit for compiling inventories to be used in developing an ozone control strategy. However, townships may provide a more convenient basis for data collection in certain New England states.

Emissions by county (or township) can be summed to compile total emissions for an entire inventory area.

2.2.7 BASE YEAR SELECTION

Selecting the appropriate base year for the emission inventory is a relatively straightforward task. The selection of the base year may depend on the years for which the agency has good air quality data, if the agency is attempting to relate air quality and emissions. However, in most control strategy inventories, the inventory base year will be determined by regulatory requirements, such as those set forth by EPA for SIP inventories. In any case, the base year should be determined before initiating data collection.

Another adjustment applicable to base year emissions is rule effectiveness (RE). RE is a factor applied to an individual source's or a source category's average emission control efficiency in order to adjust the estimated emissions to more realistic levels. EPA has allowed two approaches to establishing a RE factor. The inventorying agency may apply a RE of 80 percent for all categories. Alternatively, the inventorying agency may develop RE's for individual source categories using long term emission and process data, inspection information, or other information indicating the RE is other than 80 percent. Chapter 6 describes the calculation procedures required to apply RE.

2.2.8 TEMPORAL RESOLUTION

Because simpler source/receptor models are not as sensitive to small scale temporal variations in emissions, emission inventories used in these models do not need to be temporally resolved to the extent necessary for the more complex photochemical models. Annual emissions data are collected by most agencies for various reasons, and can be adjusted to reflect average or typical emission rates during the ozone season. An alternative approach is to collect data that represent average ozone season activity rates and emissions for each source whose emissions are likely to differ during the ozone season.

The major categories whose emissions may be significantly different during the ozone season are mobile sources and petroleum product storage and handling operations. Of course, any source whose activity is known to vary seasonally will have varying emission rates. Seasonal adjustment of emissions is discussed in Chapter 6.

2.2.9 POINT/AREA SOURCE DISTINCTIONS

A major distinction typically made in inventories is between point and area sources. Point sources are those facilities/plants/activities for which individual source records are maintained in the inventory. Under ideal circumstances, all sources would be considered point sources. In practical applications, only sources that emit (or have the potential to emit) more than some specified cutoff level of VOC are considered point sources. This cutoff level will vary depending on the needs of and resources available to the

agency. Area sources, in contrast, are those activities for which aggregated source and emission information is maintained for entire source categories rather than for each source therein. Sources that are not treated as point sources must be included as area sources. The cutoff level distinction is especially important in the VOC inventory because there are so many more small sources of VOC than of most other pollutants. Cutoff level for sources of NO_x and CO is less critical because of the significant contribution from large emitters.

If too high a cutoff level is chosen, many facilities will not be considered individually as point sources, and, if care is not taken, emissions from these sources may not be included in the inventory at all. Techniques are available for "scaling up" the inventory to account for missing sources (see Section 6.4). However, such procedures are invariably less accurate than point source methods.

If too low a cutoff level is chosen, the result will be a significant increase in (1) the number of plant contacts of various sorts that must be made and (2) the size of the point source file that must be maintained. While a low cutoff level may increase the accuracy of the inventory, the tradeoff is that many more resources are needed to compile and maintain the inventory.

An historical common upper limit on the VOC point source cutoff level is 100 tons per year. If resources allow, a lower cutoff level is encouraged. A study in several urban areas has shown the existence of many VOC sources emitting less than 25 tons per year.[4] Moreover, many of these sources are in categories for which no reliable area source inventory procedures currently exist. Because of this, some agencies have opted to define lower cutoff levels in order to cover a larger percentage of VOC emissions in a point source inventory. Lower limits, such as 10 tons per year required for VOC point sources in ozone SIP inventories, are encouraged.

Deciding the point/area source cutoff level should be done carefully. For this reason, the reader is referred to the additional discussion on the point/area source cutoffs in Chapter 3.0.

2.2.10 DATA COLLECTION METHODS

Several methods are presented in this volume for collecting data for point and area sources of VOC emissions. However, the inventorying agency must decide which procedures to use in the inventory effort. Point source methods include mail surveys, plant inspections, use of agency permit and compliance files, and source listings. Area source methods include modified point source methods, local activity level surveys, apportioning of state and national data, per capita emission factors, and emissions-per-employee factors.

To a certain extent, determining which data collection methods to employ will occur during the data collection as the agency receives feedback on the success of data collection. However, the agency should, whenever possible, determine in the planning phase which data collection methods will be used. Determining in advance which methods to use will allow time to obtain necessary reference and support materials and will help to better allocate work

hours to the individual data collection tasks as well.

The data collection methods and considerations for their use are discussed in greater depth in Chapters 3 and 4. The reader should refer to these chapters prior to selecting point and area source collection procedures for a VOC emission inventory.

2.2.11 EXCLUSION OF NONREACTIVE COMPOUNDS AND CONSIDERATION OF SPECIES INFORMATION

While most volatile organic compounds ultimately engage in photochemical reactions, some are considered nonreactive under atmospheric conditions. Therefore, controls on the emissions of these nonreactive compounds do not contribute to the attainment and maintenance of the national ambient air quality standard for ozone. These nonreactive compounds are listed below:

Methane
Ethane
1,1,1-Trichloroethane (methyl chloroform)
Methylene chloride
Trichlorofluoromethane (CFC 11)
Dichlorodifluoromethane (CFC 12)
Chlorodifluoromethane (CFC 22)
Trifluoromethane (FC 23)
Trichlorotrifluoroethane (CFC 113)
Dichlorotetrafluoroethane (CFC 114)
Chloropentafluoroethane (CFC 115)

These compounds should be excluded from emission inventories used for ozone control strategy purposes.

Most of the nonreactive volatile organic compounds that should be excluded are halogenated organics that find principal applications as cleaners for metals and fabrics, as refrigerants, and as aerosol propellants. Hence, major emitting sources of many of these nonreactive compounds can be readily identified because the sources should be able to specify which solvents are being used in their operations. To this end, solvent use information is generally requested on most questionnaires and should be solicited in any other types of plant contacts.

All combustion sources will emit methane and lesser amounts of ethane. Most emission sources will not be able to tell the agency what fraction of their VOC emissions are comprised of these nonreactive compounds. Reference 6 should be consulted for information on species compositions of various VOC emitting sources. Highway vehicles represent the most important combustion source emitting significant quantities of methane. Available EPA emission factors allow the user to exclude methane from highway vehicle emissions.[7]

Even though species data are not needed in the basic inventory, the agency may find it worthwhile in some instances to collect available speciation information when plant contacts and surveys are made during the basic inventory

compilation effort. Species data are necessary if an agency anticipates using a photochemical model. Moreover, certain toxic organic materials data may be needed for use in other regulatory programs. If either of these other activities is planned for the near future, species data should be collected at the same time that the other source and emissions data are collected for the basic inventory. In this regard, the agency should minimize the number of contacts required to any one source. Where speciation data are not collected directly, source-specific speciation profiles in Reference 6 can be used to develop an inventory of VOCs grouped into reactivity classes suitable for oxidant modeling, and can also be used to develop preliminary estimates of specific toxic emissions. While this application for a few specific toxics would be fairly practical, speciation of an entire area's inventory in this manner is a major project requiring extensive data processing support.

2.2.12 EMISSION PROJECTIONS

An essential element in an ozone control program is emission projections. Two types of projections are usually made: baseline and control strategy. Baseline projections are estimates of emissions in some future year that take into account the effects of growth and existing control regulations. Because it takes anticipated growth into account but does not allow for changes in control regulations, a baseline projection is essentially an estimate of what emissions would be if no new control measures were put in place. The baseline projection inventory is important in a control program as a reference point to determine if precursor pollutant reduction is sufficient to meet the ambient ozone standard. The baseline projection inventory can serve as an accurate reference point only if expected growth is included.

In contrast, control strategy projections are estimates of emissions in some future year and take additional control measures into consideration. Control strategy projections should be made for the same projection years as the baseline projection inventories. This enables the agency to compare directly the relative effectiveness of each strategy as well as to determine which strategy provides the necessary control of ozone precursor emissions as indicated by the source/receptor relationship.

Two fundamentally different approaches can be used to make projections. Simple but somewhat crude projections can be made by multiplying base year summary emission estimates by general growth factors such as industrial output. Typically, such growth factors have been adjusted to reflect some average measure of control reduction for each source category.

The alternative to the above approach is to make detailed projections for each point source. In such a detailed approach, information on anticipated expansion, process changes, and control measures is collected from each source at the same time and in the same manner as are the base year source and emissions data. As a result of this approach, an entire inventory file is created for the projection year. This second approach should result in more accurate projections because growth to capacity, new growth, and individual control measures can all be taken directly into account. Because of increased accuracy, the agency should consider making projections at the greatest level

of detail possible within given resource constraints. If the agency anticipates building on the basic inventory at some later date in order to run a photochemical model, detailed projections are needed to provide the temporal and spatial resolution necessary in such models. Emission projections are discussed in Chapter 6.

When making projections, the agency should check that consistent methodologies are used for each source category in both the base year and projection year inventories. If different procedures are used for estimating emissions, the agency cannot be sure if changes in emissions are due to its proposed control program or are simply due to methodological differences. For example, if local dry cleaning solvent consumption is determined from plant questionnaires in the base year, projection year solvent consumption should not be estimated by apportioning projected nationwide solvent use to the local level.

Another important planning factor consider is that the structure of the inventory determines how readily the effect of various control strategies can be estimated. For example, if a certain control measure is to be imposed on "perc" dry cleaning plants, the effect of that control is more readily simulated in a projection year inventory if emission totals for perc plants are maintained separately from emissions from plants using petroleum or fluorocarbon solvents. Thus, the agency should anticipate what control measures are likely candidates for evaluation and should structure the source categories, data elements, and reporting capabilities accordingly, so these measures can be easily reflected in the projection inventory. Table 2.2-1 and Appendix B illustrate a format which includes most categories for which control measures have been or will be developed.

2.2.13 STATUS OF EXISTING INVENTORY

A major inventory design consideration, especially if the agency is faced with limited resources, is whether an existing inventory can be used as is, or can be selectively modified, to meet the current needs of the ozone control program. No specific guidance can be offered here, since existing inventories will obviously differ as will the current needs of each agency. At a minimum, the existing inventory should be examined to see if the appropriate sources have been included and if the emissions data therein are reasonably representative of current conditions. The point source cutoff level should be compared with current requirements. An existing inventory that cannot meet current needs and cannot readily be updated or modified should not be discarded. Previous inventories can serve as a starting point for the development of a mailing list for questionnaire distribution. The agency must be careful, however, not to rely on an existing inventory to the degree that important sources or source categories are excluded. These sources may either have been (1) erroneously omitted when the original was prepared or (2) omitted because sources were never required to obtain permits. In the latter case, many inventories have historically been compiled for particulates (PM) and SO_x with little emphasis on sources exclusively emitting VOC. Any backup information, such as the response time required for questionnaires, kept on the existing inventory can also be helpful. Likewise, any specific emission

factors, per capita factors, or other rules of thumb resulting from a previous inventory may be applicable in a current effort.

2.2.14 CORRESPONDING NITROGEN OXIDES (NO_x) AND CARBON MONOXIDE (CO) INVENTORIES

Nitrogen oxides and carbon monoxide, along with volatile organic compounds, are precursor emissions that react to form photochemical oxidants. Consequently, NO_x and CO emission inventories are important in an ozone control program. In the EKMA model, estimates of VOC, NO_x, and CO are directly used to generate the city-specific ozone isopleths.[3]

NO_x and CO emissions are generally easier to inventory than VOC because most originate from combustion sources. Mobile sources and boilers typically account for the bulk of NO_x and CO emissions in most urban areas. Other combustion sources include internal combustion engines, incinerators, industrial sources using in-process fuels, and various open burning operations. In general, the procedures presented in this volume will adequately cover all of these sources. Reference 5 was developed as a general guidance for preparation of criteria pollutant emission inventories and therefore is also recommended for use in inventorying NO_x and CO.

2.2.15 DATA HANDLING

The agency conducting an emission inventory should be aware that data handling and retrieval can be done by computer or manually. Combinations of these two basic approaches are also possible. The selection of one approach over the other will depend on several factors:

- availability of a computer
- size of the inventory data base
- complexity of the emission calculations
- number of calculations to be made
- variety of tabular summaries to be generated
- availability of clerical and data handling personnel
- time constraints.

The computer approach becomes significantly more cost effective as the data base, the variety of tabular summaries, or the number of iterative tasks increases. In these cases, the computer approach generally requires less time and has the added advantage of forcing organization, consistency, and accuracy.

Some of the activities which can be performed efficiently and rapidly by computer include:

- printing mailing lists and labels
- maintaining status reports and logs
- calculating and summarizing emissions
- storing source, emissions, and other data

- sorting and selective accessing of data
- generating output reports.

Therefore, during the planning stages, an agency should anticipate the volume and types of data handling needed in the inventory effort and should weigh relative advantages of manual and computerized systems. In general, if an agency must deal with large amounts of data, a computerized inventory data handling system allows the agency to spend more time gathering and analyzing the inventory data. In this sense, the computerized approach is superior in large areas having a diversity of sources comprising a complex inventory.

If the agency anticipates use of a photochemical dispersion model, a computerized data handling system is imperative. The added complexity involved in developing spatially and temporally resolved estimates of several VOC classes from the basic inventory simply represents too much work to complete manually. Data handling requirements for inventories used in photochemical models are discussed in Volume II.

Quality assurance is another consideration for selecting a computer system for data handling. Emission calculations and editorial checks can be conducted much faster by computer than by manual means. Thus, how an agency intends to conduct quality assurance tests on the emission inventory should be considered when deciding between manual or computer data handling systems.

2.2.16 DOCUMENTATION

Documentation is an integral part of an emission inventory. When an inventory's supporting materials are documented, errors in procedures, calculations, or assumptions are detected more easily. In addition, a well-documented inventory will be a defensible data base which is valuable in enforcement actions, source impact assessments, and development of emission control strategies.

While documentation requirements may evolve during the data collection, calculation, and reporting steps of the emission inventory, these requirements should be anticipated in the planning phase. Planning what level of documentation is required will (1) ensure that important supporting information is properly developed and maintained, (2) allow extraneous information to be identified and disposed of, thereby reducing the paperwork burden, (3) help determine hard copy file and computer data storage requirements, and (4) aid in identifying aspects of the inventory on which to concentrate quality assurance efforts. Thus, planning documentation for the emission inventory will benefit both the emission inventory effort and the agency.

2.2.17 ANTICIPATED USE OF A PHOTOCHEMICAL DISPERSION MODEL

The basic inventory compiled for use with a less data intensive source/receptor model can serve as a good starting point for creating a photochemical modeling inventory. If the agency expects to use a photochemical dispersion model at some subsequent date without redoing the existing data

base, certain considerations should be incorporated in the basic inventory effort from the outset.

An example of such a consideration is given in Section 2.2.15. Because of the extensive data handling activities required in producing a photochemical modeling inventory, a computerized inventory file should be developed from which a "modeler's tape" can be created. (The modeler's tape is the final inventory product that is actually input to the photochemical model.)

The amount of source data that should be collected during the basic inventory update will be increased if the agency anticipates the use of a photochemical dispersion model. Information sufficient to allow the agency to develop the necessary spatial and temporal resolution and VOC classifications is needed by these models. Specifically, (1) detailed locational coordinates and stack data should be obtained for each point source (this information is already maintained in many basic inventory systems), (2) socioeconomic data should be obtained for subsequent area source apportioning, (3) daily and hourly operating patterns are needed for the ozone season, and (4) VOC species profiles should be defined for each emissions category. In order to minimize the number of contacts made to any particular source, the agency should obtain as much of this additional information as possible during the contacts made to update the basic inventory. Volume II further discusses the data requirements for photochemical modeling inventories.[1]

A third consideration influences the structure of the basic inventory. Because VOC emissions must be apportioned into various classes in the photochemical modeling inventory, the basic inventory should be structured to facilitate this step. To a large extent, this can be effected by a judicious choice of source categories. As an example, dry cleaning plants using perchloroethylene should be distinguished from those using petroleum solvent because each of these solvents needs to be apportioned differently into VOC classes. As another example, evaporative and exhaust emissions from gasoline powered vehicles should be distinguished because their emissions mix of organic species will differ. In general, if separate emission totals can be maintained for the important solvents used in an area, and the exhaust/evaporative distinction is maintained for gasoline powered vehicles, the basic inventory can readily be used for generating the VOC classifications needed by photochemical models. Maintaining separate totals for various solvent types is useful in the basic inventory as well, because the agency can more readily exclude those particular compounds (discussed in Section 2.2.11) that do not participate in ozone formation. As discussed in Section 2.2.10, speciation profiles in Reference 6 can be used to create a full inventory of VOC reactivity classes appropriate for use on a modeler's tape.

The agency should review Volume II[1] of this series during the planning stages of the basic inventory process if the agency contemplates a photochemical model for future modeling analyses.

2.2.18 PLANNING REVIEW

By the completion of the planning phase of the inventory effort, and prior to initiating the data collection phase, the agency should have addressed the items listed below.

- The end use(s) of the inventory are established.

- Source categories have been defined which are compatible with available source and emission information and are of sufficient detail to facilitate control strategy projections excluding nonreactive compounds.

- Manpower and budget allocations have been made.

- The geographical inventory area has been identified and the necessary spatial allocation determined.

- The inventory base year has been selected.

- Decisions have been made on how to adjust emissions seasonally, which sources will be seasonally variable, and whether emissions will be compiled annually and/or daily.

- The point source cutoff has been defined, the relative quantity of sources below the emissions cutoff level has been estimated, and scale up and area source procedures selected.

- The best collection methods for point and area source data have been determined.

- Procedures for excluding nonreactive emissions have been established.

- The agency has decided how emissions will be projected, and the projection period, including end year and intermediate years, has been designated.

- The role of existing inventory data has been determined and any previously omitted important sources have been identified.

- All sources of NO_x and CO emissions have been identified, including noncombustion industrial processes which do not emit VOC.

- An inventory data handling system has been selected.

- Quality assurance procedures have been selected.

- The agency's future use of a photochemical dispersion model has been considered and the appropriate adjustments in inventory plans have been made, including review of Volume II, if necessary.

References for Chapter 2.0

1. Procedures for the Preparation of Emission Inventories for Volatile Organic Compounds, Volume II, EPA-450/4-79-018, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1979.

2. Compilation of Air Pollutant Emission Factors, Fourth Edition and Supplements, AP-42, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1985.

3. Uses, Limitations and Technical Basis of Procedures for Quantifying Relationships between Photochemical Oxidants and Precursors, EPA-450/2-77-021a, U.S. Environmental Protection Agency, Research Triangle Park, NC, November 1977.

4. Mahesh C. Shah and Frank C. Sherman, "A Methodology for Estimating VOC Emissions from Industrial Sources," presented at the 71st Annual Meeting, American Institute of Chemical Engineers, Miami Beach, FL, November 1978.

5. Procedures for Emission Inventory Preparation, Volumes I-V, EPA-450/4-81-026, a-e, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1981.

6. Air Emissions Species Manual, Volume I: VOC Species Profiles, EPA-450/2-88-003a, U.S. Environmental Protection Agency, Research Triangle Park, NC, April 1988.

7. User's Guide to MOBILE3, EPA-460/3-84-002, U.S. Environmental Protection Agency, Ann Arbor, MI, June 1984. (MOBILE4 currently under development.)

3.0 POINT SOURCE DATA COLLECTION

3.1 INTRODUCTION

As discussed in Chapter 2, point sources are those facilities/plants/activities for which individual records are maintained in the inventory. Inventory planning decisions affecting the scope of the point source inventory include: the cutoff level distinguishing point from area sources and data collection procedures for each facility or category.

The choice of a point source cutoff level will not only determine how many point sources will be contained in the inventory, but also will affect the kinds of sources included. As a rule, the lower this cutoff level is, (1) the greater the cost of the inventory, (2) the more confidence users will have in the source and emissions data, and (3) the more applications that can be made of the inventory. Historically, all facilities exceeding 100 tons of VOC per year have been inventoried as point sources and each process emission point or set of mission points per vents identified. If possible, a point source cutoff level of less than 100 tons per year, such as the 10 ton per year SIP cutoff, should be selected to avoid handling the myriad of medium size VOC emitters found in most urban areas as area sources. In some cases, the agency may decide to pursue lower cutoff levels or to include all of a certain type of source in the point source inventory, regardless of size. This may be desirable, for example, if all sources in a certain category are subject to control regulations such as RACT.

All planning considerations discussed in Chapter 2 should also be taken into account prior to the point source data collection effort. At a minimum, every source category shown in Table 2.2-1 and the process emission points shown in Appendix B should be considered for inclusion, with an emphasis on those RACT categories for which controls are anticipated in the ozone control program. As an aid to the agency in this regard, Appendix C contains summary information on each source category for which EPA has published a Control Techniques Guideline (CTG) document. This information can help the agency decide whether a given source category (or some segment thereof) should be included in the point source inventory, what processes need to be identified as distinct emitting points, what kinds of controls represent reasonably available technology, and what presumed reductions are related to the implementation of these controls. The CTG documents cited in Appendix C should be reviewed by the inventory agency, as they contain a great deal of detailed source, emissions, and control device information on the major sources that a VOC inventory should encompass.

The second major decision regards what particular data collection procedures are to be applied for each point source category. Most point source procedures have two common elements: (1) some sort of direct plant contact and (2) an individual point source record generated as a result of the plant contact and maintained as a separate entry in a point source file. Plant contacts of various sorts can be made. The two most common types of plant contact are the mail survey and direct plant inspections. A type of indirect plant contact also commonly employed is the use of permit applications or

compliance files. These three techniques for collecting point source data are discussed in this chapter.

An alternate method for collecting data for small VOC point sources, i.e., those plants that emit between 10 and 25 tons per year, involves surveying a statistical sample of sources in each source category to estimate emissions in the geographical area under consideration. For each source category inventoried using this method, the sample survey should identify the location, activity (production, throughput, and number of employees), and emissions for a representative sample (e.g., ten percent) of the 10 to 25 tons per year plants in the area. The location and activity level of the remaining 10 to 25 tons per year plants can be identified using information from business survey statistics, trade associations, Chambers of Commerce, etc.

Under this method, emissions for each plant should then be estimated by extrapolating the data collected in the sample survey (e.g., emissions-per-throughput or emissions-per-employee) to the remaining sources. The advantage of this alternate method is that locations and emission estimates are identified for individual plants without having to contact each plant. These statistical estimates for the 10 to 25 tons per year plants should not be used as a baseline for new source review or emissions trading policies.

It is often difficult to estimate emissions from sources that operate on a batch or intermittent schedule. These sources may be found in many different source categories (Chemical Manufacturing, Surface Coating, etc.). Differing levels of operation may be due to varying demand for the product(s), changes in the type of items produced, availability of raw materials, and other causes. Emissions from such sources can vary from day to day, month to month, or year to year. Personnel involved in such operations may find it difficult to estimate their "average ozone season" emissions, especially on a daily basis.

Another problem associated with these types of facilities is that records of material usage needed for estimating emission rates are often not maintained. Materials usage fluctuates as to the amount and the type used when processes are changing over time. Therefore, estimates of emissions from material usage for a "typical" operating period are not readily available.

A few approaches to address these problems are described in the following discussion. The most precise approach requires that the source have adequate advanced notice prior to beginning data collection. This requires the agency performing an inventory to plan in advance of the inventory period and to identify the facilities that will be included in the inventory that are likely to have such operations. Those facilities can be contacted before the actual inventory and advised as to what information must be collected. Data can then be averaged over the period of interest (month, ozone season, year, etc.) either by the agency or the facility. Any such inventory should include information as to the proportion of the facility operating schedule dedicated to each process, as well as separate material usage for each process. Such information can then be used to develop emission factors if they do not already exist for such a source category or process.

Often, time or resources for advanced planning will not be available for a pre-inventory contact of facilities or a sample of facilities. In such cases, the agency may apply generalized estimates of process schedules, materials usage, and other information from the recollections of plant operators and the available plant records (bills of lading, receipts for raw materials, etc.).

Combinations of the above two approaches may also be undertaken. In such a study, a sample of facilities (either randomly selected or those deemed representative) are contacted before the study period of the inventory. Information collected for each process should include schedule for the period, type of materials used, quantity of materials used, and the amount of end product produced. Emission factors based on the amount of product for each surveyed process could then be used to estimate emissions from the facilities outside the pre-inventory sample. For example, the amount of each product shipped from a facility could be collected through facility records and could be used with an emission factor to determine an emission rate.

It should be noted that the above mentioned approaches are general in nature. Gaining an accurate picture of the emissions from batch or intermittent processes may be costly in time and resources. The contribution of such processes to the emissions in a study region should be considered before determining which approach is most appropriate for the particular inventory.

3.2 QUESTIONNAIRES (MAIL SURVEY APPROACH)

The mail survey is a technique commonly used by air pollution control agencies for gathering point source emission inventory data. The primary purpose of a mail survey is to obtain source and emissions data by means of a questionnaire mailed to each facility. In order to conduct this type of data gathering operation, the facilities surveyed must be identified; mailing lists must be prepared; questionnaires must be designed, assembled, and mailed; data handling procedures must be prepared and organized; and response receiving systems must be established. The following text discusses the details of each of these general operations.

3.2.1 PREPARING THE MAILING LIST

A necessary step in the mail survey is the preparation of a mailing list that tabulates the name, address, and general process category of each facility to be surveyed. The basic function of the mailing list is to identify those sources to which questionnaires will be sent. The mailing list may also serve other functions. For example, the general process category information obtained from the mailing list can assist the agency in determining those categories for which questionnaires must be designed. In addition, the size of the resulting mailing list gives the agency an indication of the numbers and types of sources that can effectively be considered in the point source inventory within resource limitations. In this regard, the mailing list can be used to help the agency determine whether the resources allocated for the compilation effort will be sufficient.

The mailing list is compiled from a variety of information sources, including the following:

o Existing inventories - A recent or recently updated, well-documented, existing inventory is a good starting point. Note that many inventories are compiled for pollutants other than VOC and certain sources, such as solvent users emitting only VOC, may not be well-represented in existing inventories. Moreover, some sources of VOC considered collectively as area sources within the existing inventory may, instead, need to be treated as point sources in the updated VOC inventory.

o Other air pollution control agency files - Compliance, enforcement, permit application, or other air pollution control agency files may provide valuable information on the location and types of sources that exist in the area of concern. These files can also be used later to cross check certain information supplied on questionnaires.

o Other government agency files - Files maintained by labor departments and tax departments frequently aid in the preparation of the mailing list. Such files will include various state industrial directories wherein companies are listed alphabetically by SIC and county. The information available in these files will vary from state to state. Thus, it is advisable to contact the appropriate personnel within these agencies to become familiar with what listings are available.

o EPA/CTG source listings - EPA's Stationary Source Compliance Division has developed point source listings for several source categories for which CTG documents have been published.[1-8] The listings provide a company name, address, and in some cases, a phone number for each source. These listings are available through EPA Regional Offices upon request by a state or local air pollution control program. In addition, EPA is developing a more detailed RACT compendium for VOC sources.

o Other local information sources - The following local information sources can be consulted, where available:

- Local industrial directories - A local industrial development authority may provide a list of the latest sources which operate in the inventory area.

- Yellow Pages - The local telephone directory will have names, addresses, and telephone numbers of many industrial/commercial VOC sources. Note that telephone directory areas often do not correspond to county or community boundaries.

- Manufacturers and suppliers - Contact firms that make or supply equipment and materials such as solvents, storage tanks, gasoline pumps, incinerators, or emissions control equipment used in industries emitting VOC, NO_x, and CO. Some firms have good contacts within industry and may be able to provide information concerning the existence and location of such sources.

o National publications - The national publications listed below can be used when available. However, the information contained in them may be older and less accurate than local primary references.

- Dun and Bradstreet, Million Dollar Directory[9] - Companies with sales over $1,000,000 a year are compiled by SIC and county.

- Dun and Bradstreet, Middle Market Directory[10] - Companies with sales between $50,000 and $1,000,000 a year are compiled by SIC and county.

- Dun and Bradstreet, Industrial Directory[11]

- National Business Lists[12] - Companies are listed by SIC and county with information on financial strength and number of employees.

- Trade and professional society publications[13,14] - Names and addresses of members are listed along with their type of business.

In the compilation of the final mailing list, special attention should be given to the Standard Industrial Classification (SIC) code associated with each source. SICs are a series of codes devised by the U.S. Office of Management and Budget to classify establishments according to the type of economic activity in which they are engaged.[15] If an SIC corresponds to one given in Table 3.2-1, an increased likelihood exists that the source is an important source of VOC emissions.

The mailing list should be organized to facilitate the necessary mailing list and followup activities. A logical order in which to list companies is by city or county, then by SIC, and finally, alphabetically. Ordering the list in this manner will increase the efficiency of all subsequent data handling tasks and will allow a quick quality control checking of the resulting listing.

3.2.2 LIMITING THE SIZE OF THE MAIL SURVEY

If more sources are identified on the mailing list than can be handled within available resources, the agency should screen the mailing list in some manner to reduce the number of facilities to be sent questionnaires. This can be done in a number of ways. One way is to limit the mailout to only those sources believed to emit more than a certain quantity of VOC (or NO_x or CO) annually. Appendix C contains estimates of typical VOC emissions associated with industrial processes within many important source categories. These typical emission estimates can be used to determine if certain operations should be handled as point or area sources. For example, in Table C-21 of Appendix C, typical coin operated ("coin-op") and commercial dry cleaning plants are estimated to emit only 1.6 and 3.6 tons per year, respectively. Hence, if the point source cutoff level is 25 tons per year, the agency may decide to treat all coin-op and commercial plants as area sources, and not to send them questionnaires.

TABLE 3.2-1 STANDARD INDUSTRIAL CLASSIFICATIONS (SICS) ASSOCIATED WITH VOC EMISSIONS; EMISSIONS-PER-EMPLOYEE RANGES[16,17]

General 2-Digit SIC Categories	Specific 4-Digit SIC Categories	Emissions-Per-Employee Ranges (tons/employee/yr)
20 Food	Alcoholic beverages (2085)	0.075
21 Tobacco		-
22 Textiles	Coating (2295), Non-wovens (2297), Dyeing (2231)	0.536-0.89
23 Apparel		-
24 Lumber & Wood	Finished product (2435), (2492)	0.024-0.07
25 Furniture & Fixtures	SIC: (2511), (2514), (2521), (2522), (2542)	0.08-0.24
26 Paper	Bags, box (2643), (2651), (2653), Coated papers (2641)	1.0-1.25
27 Printing	Newspaper publishing (2711), Comm. printing (2751), (2754)	0.08-0.5
28 Chemicals	Organic chemical mfg. (2821), (2823), (2861), Chemical coating (2851), Specialty chemical (2842), Carbon black (2895)	0.32-0.357
29 Petroleum	All companies	0.11-2.12
30 Rubber, Plastic	Footwear (3021), Plastics	0.16-0.256
31 Leather	(3021) (3089) Mfg. shoes (3149), Bags (3161), Personal goods (3172), Leather refinishing (3111)	0.13
32 Stone, Clay, etc.	Glass products (3221)	0.03-0.092
33 Primary Metal	Treating (3398), Tubing (3357)	0.10-0.267
34 Fab. Metal	Screws (3451-2), Metal stampings (3469), Plating (3471), Tool mfg. (3423), (3429)	0.19-0.281
35 Machinery	Industrial machines	0.03-0.048
36 Elect. Machinery	Devices (3643), Semicond. (3674)	0.04-0.07
37 Transpt. Equip.	Boats (3732), Motor vehicles (3711-15)	0.11-0.855
38 Instruments	Optical frames (3832) Precision instruments	0.04-0.199
39 Misc. Mfg.	Jewelry (3914-15), Toys (3944), Writing instr. (3951,53)	0.07-0.59
51 Nondurable Goods - Wholesale	Bulk terminals (5171)	-
72 Personal Services	Dry cleaning (7216)	-

In many instances, the number of employees in a company will be known, and an estimate of the potential magnitude of emissions can be made by applying emissions-per-employee factors, such as are shown in Table 3.2-1. The range of emissions in Table 3.2-1 for some two-digit SIC categories suggests that this technique may yield widely varying estimates of a source's annual emissions. If the agency has sufficient budgeted resources, the higher emissions-per-employee factors can be used. This will cause an initial overestimate of each point source's emissions, placing more sources above the determined cutoff level. As a result, questionnaires will be sent to more sources.

Employee data is also useful in identifying facilities which should be handled as point sources. Depending on the agency's point source cutoff, a minimum number of employees per facility may be used as a surrogate parameter for emissions. Table 3.2-2 lists an approximate number of employees per facility for each of eight source categories, which may exceed a 10 or 25 ton per year emissions cutoff. Emissions-per-employee factors are included in the table for each of the sources.

Another method for reducing the mailing list to a manageable size is to make telephone contacts to selected sources within each major category. If there is any doubt about particular source types being potentially large emitters, brief contacts with plant managers or other appropriate employees at a few representative facilities may indicate if VOC emitting processes are common. Moreover, by obtaining activity levels or the number of employees, the agency can estimate what facilities within the source category will be of sufficient size to warrant sending a questionnaire.

3.2.3 DESIGNING THE QUESTIONNAIRES

A questionnaire must be prepared for each facility to be contacted. This can be done either by preparing industry-specific questionnaires for each source category or by preparing "catchall" questionnaires that encompass many source categories. If sufficient resources are available, use of industry-specific questionnaires is advantageous for certain sources. Such questionnaires will generally be shorter because questions not applicable to the particular industry need not be included. In addition, such a questionnaire can use industry-specific terminology that is familiar to those working in a particular industry. This can enhance communication and reduce confusion and inventory accuracy is increased. On the other hand, use of industry-specific questionnaires has several disadvantages. One disadvantage is that the design of many industry-specific questionnaires can require significant resources. Second, the returned questionnaires must be processed individually because of the variations in format for different industries. Third, industry-specific questionnaires may be incorrectly sent to some sources because of limited prior knowledge of the operations at these sources.

One approach to using industry-specific questionnaires involves review of the questionnaires by engineers familiar with the particular type of source to

TABLE 3.2-2. SURROGATE PARAMETERS TO IDENTIFY SMALL SOURCES EXCEEDING 10 AND 25 TPY VOC EMISSIONS

Emission Source	Standard Industrial Classification	No. Employees per Facility for: 10 TPY	25 TPY
Graphic Arts			
Commercial Flexographic	2759	12	30
Commercial Rotogravure	2754	12	30
Metal Coil Coating	3479	15	40
Furniture Coating	2511,2514	15	40
	2517-2542	65	160
Miscellaneous Metal Parts & Products Coating	3412-3449	40	100
	3465-3499	25	60
	3511-3599	60	150
		Gallons per Month per Facility for: 10 TPY	25 TPY
Bulk Gasoline Plants	4226,5171	65,000	a
Gasoline Service Stations[b]	5541	80,000	200,000

[a]Plants emitting 25 TPY VOC would have a throughput exceeding 100,000 gallons per month and would be considered bulk terminals.

[b]Estimates based on service stations operating with submerged fill, vapor balance with no Stage II controls.

assure adequate, timely, and accurate responses. A questionnaire can be mailed to every APCD permitted source.

Another approach which can be used is to develop long-form and short-form industry-specific questionnaires. In this approach, long-form questionnaires can be designed to gather detailed information about major industrial groups. Specific process instructions should be developed to accommodate different types of industries. The short-form questionnaires can specifically address certain categories of industries such as: General Industrial, Natural Gas Processing, Grain Elevators, Mineral Products, Wood Products, Metal Products, Cotton Gins, and VOC Storage Terminals. Depending on the type of industry, each facility will receive either a long-form or a short-form questionnaire.

The use of general questionnaires may be advisable if the mailing list is long, if the agency is unfamiliar with many of the sources on the list, or if agency resources are limited. Oftentimes in practice, a general questionnaire is merely a collection of process-specific questionnaires.

Questionnaire design entails the establishment of a suitable format, the selection of appropriate questions, the wording of questions, and the development of an cover letter and instructions for filling out the questionnaire. The basic rule is to design the questionnaire for the person who will be asked to complete it. The agency should consider that the person who will complete the questionnaire may not have the benefit of a technical background in air pollution, engineering, or physical sciences. Hence, questionnaires should be designed to be understood by persons without specialized technical training.

The format of the questionnaire should be as simple and as functional as possible. When data handling is to be done by computer, time will be saved if the questionnaire format is such that data entry personnel can readily enter the information directly from each questionnaire. The questions should be well-spaced for easy readability with area sufficient for complete responses. The questionnaire should be as short as possible as lengthy questionnaires can be intimidating. Also, shorter questionnaires reduce postal costs. When preparing the questions, use terminology with which the recipient will be familiar. Each question should be self-explanatory or accompanied by clear directions. All necessary information should be solicited on the questionnaire, thus avoiding later requests for additional data. Any additional data needed for subsequent application of a photochemical model should also be collected at this same time, as well. (Volume II describes these necessary additional data.[18])

Each questionnaire sent out should be accompanied by a cover letter stating the purpose of the inventory and citing any statutes that require a response from the recipient. The letter should include a simple explanation of the ozone problem and should relate VOC, NO_x, and CO emissions to ozone formation. If the inventory is for an ozone nonattainment area, some discussion of the implications of the nonattainment designation might be advisable. Cooperation in filling out and returning the questionnaire should be respectfully requested. In addition, each questionnaire should be

accompanied by a set of general procedures and instructions telling the recipient how the questionnaire should be completed out and by what date it should be returned to the agency. In lieu of putting a specific reply date in the cover letter, a specific number of calendar or working days in which to respond can be included. In this manner, delays in mailouts will not require the changing of the reply date in each letter. If a general questionnaire is sent out, the instructions should carefully explain that the questionnaire has been designed for a variety of operations and that some questions or sections of the questionnaire may not apply to a particular facility. In all cases, a contact name, telephone number, and mailing address should be supplied in case a recipient has questions. The cover letter and instructions can be combined in some cases, but this should only be done when the instructions are brief. An example cover letter and set of instructions are shown in Appendix D. A variety of additional examples are presented in Reference 19.

The ultimate use of the data should always be considered when determining the information to request on the questionnaire. Process information should also be requested in addition to general source information such as location, ownership, and nature of business. Since activity levels, including indicators of production and fuel consumption, are generally used with emission factors to estimate emissions from most sources for which source test data are not available, the appropriate activity levels must be obtained for each type of source. The type of activity levels needed to calculate emissions from point sources are defined for most VOC emitters in AP-42.[20] In addition, since many of the emission factors in AP-42 represent emissions in the absence of any controls, control device information should also be obtained in order to estimate controlled emissions. Control device information is also helpful for determining potential reductions in emissions from applying various control strategies, especially for those source categories for which CTG documents have been published. Finally, any information that is needed to make corrected or adjusted emission estimates should be solicited. For example, since emissions from petroleum product storage and handling operations are dependent on a number of variables, including temperature, tank conditions, and product vapor pressure, appropriate values should be obtained for these variables that will allow the agency to apply the correction factors given in Chapter 4 of AP-42. If seasonal adjustments are considered, special emphasis should be given to variables such as activity levels, temperature, and windspeed that cause seasonal variations in emissions. (Seasonal adjustment of emissions is discussed in Chapter 6.)

Other information may be solicited in the questionnaires depending on the agency's needs in its ozone control program. For example, stack data such as stack height and diameter, exhaust gas temperature, and flow rates may be required for modeling purposes. Information on fuel characteristics, generally sulfur, ash, and heat contents, may also be desirable. Certain compliance information may be needed if the agency is using the inventory for enforcement purposes. Information on the nature or brand name of any solvents is particularly helpful to the agency in excluding nonreactive VOC from the emission totals. Process schematics, flowcharts, and operating logs may be requested to be returned with the questionnaire in cases where the source is

unique and/or complex. Each source should be requested to include documented emission estimates or to enclose source test results, if available.

An example cover letter, instruction sheet, and questionnaire package aimed specifically at obtaining information on solvent users is shown in Appendix D. A number of the elements required in a questionnaire package are illustrated in this example. It should be noted that the questionnaire will not be applicable to all major VOC emitting sources. Additional questionnaires must be developed to cover refineries, chemical manufacturers, and other VOC sources. Various example questionnaires dealing with many of the major source categories are presented in Reference 19. Before adopting any of the example questionnaires, the agency should carefully consider the objectives of the inventory in an ozone control program, and should then determine if the data supplied in response to these questionnaires will meet these objectives.

Questionnaires accommodating all variations of process operation even in the same industry category are difficult to design and keep to manageable size. Thus, segments of some of the questionnaires may be unformatted, asking the plant contact to describe the source and its emissions. Unformatted areas on questionnaires should be avoided to minimize confusion both to the person completing the questionnaire and to the agency. Each section of the questionnaire should describe what information is needed, the units in which the data should be expressed, and where on the form the requested data should be located.

While questionnaires are tools generally used for obtaining point source data, they can be used to collect certain area source data as well. For example, many questionnaire recipients emit so little that the agency may not want to maintain an individual record for each source. Instead, the agency could group them in an area source category such as small dry cleaning establishments. In some situations, questionnaires can be used to obtain area source information directly. For example, the amount of fuel or solvent consumed collectively by residential and commercial customers may be collected by contacting suppliers. Frequently, area source emissions will be determined through other techniques, such as field surveys or the use of information found in special publications. Area source data collection techniques are included in Chapter 4.

3.2.4 MAILING AND TRACKING THE QUESTIONNAIRES AND LOGGING RETURNS

Once the final mailing list has been compiled and the appropriate questionnaire packages are assembled (including mailing label, cover letter, instructions, questionnaires, and self-addressed stamped envelope), the agency should proceed with the mailout activities. The mailing of the questionnaires can be performed in two ways. The first method is by registered mail, which informs the agency when a questionnaire is received by the company. This does not guarantee that the company will return the form, but the rate of response will probably be somewhat greater than if the questionnaires are sent by first class mail. However, the slight increase in response may not justify the added expense of sending every company a registered letter. As a compromise, registered mail may be used to contact only major sources.

The second method is to send the questionnaires by conventional first class mail. This method has proven to be effective if the address includes the name of the plant manager or if "Attention: PLANT MANAGER" is printed on the outside of the envelope. This directs the envelope to the proper supervisory personnel and reduces the chances of the questionnaire package being discarded. It is highly recommended that a stamped envelope be included with each questionnaire as the questionnaire is thus more likely to be returned.

Generally, responses will begin arriving in within a few days after mailing. Many of the early returns may be from companies that are not sources of VOC emissions. Also, some of the questionnaires will be returned to the agency by the postal service because either the establishment is out of business or the company is no longer located at the indicated mailing address. New addresses for companies that have moved can be obtained by either calling the establishments, looking up their addresses in the telephone book or contacting an appropriate state or local agency, such as the tax or labor departments.

A simple computer program can be helpful in the mailing and logging-in of the questionnaires. Such a program should be designed to produce a number of duplicate mailing labels for each source sent a questionnaire. One label is attached to the outside of the envelope containing the questionnaire materials. A second label is attached to the cover letter or instruction sheet of the questionnaire. This facilitates the identification of the questionnaires as they are returned, as well as name and mailing address corrections. Additional mailing labels may be used for other administrative purposes or to recontact those sources whose responses are inadequate. An example label is shown below:

0000 (SIC Code) 0000 (ID Number)
INDIVIDUAL'S NAME (or PLANT MANAGER)
TITLE
COMPANY NAME
STREET
CITY, STATE, ZIP CODE

It may be helpful to print the SIC code on the upper left and an assigned identification number on the upper right of the labels. The ID number is used to keep records of all correspondence with a company. If the study area is large, a county identification number may also be included on the mailing label.

It is important to develop some sort of tracking system to determine the status of each facet of the mail survey. Such a tracking system should tell the agency: (1) to which companies questionnaires are mailed; (2) the dates the questionnaires are mailed and returned; (3) corrected name, address, and SIC information; (4) preliminary information on the nature of the source; (5) whether recontacting is necessary; and (6) the status of the followup contact effort. Tracking can be accomplished manually through the use of worksheets or through the use of a simple computer program. A computer printout of the mailing list can be formatted for use as a tracking worksheet.

As soon as the questionnaires are returned, some useful analyses can be performed. One activity that can help enhance the timely completion of the mail survey, as well as assist in estimating the amount of resources that will be subsequently needed in the inventory effort, is to classify each response with respect to the pollutant in one of the five categories listed below:

P - point source
A - area source
N - No emissions (non-source)
OOB - Out of business
R - Recontact for reclassification

In addition, the agency can begin performing emission calculations for those sources that do not supply emission estimates, and the resulting source and emission information can begin to be loaded into the inventory files. All responses should then be filed by SIC, source category, geographic location, alphabet, or by any other criteria that enable orderly access for additional analysis.

3.2.5 RECONTACTING

The agency may have to recontact sources by the agency for either of two reasons: the source may not have returned the questionnaire at all, or the response provided may not have been adequate to meet the agency's needs. If the source has not returned the questionnaire as requested, the source can be recontacted by a more formal letter citing statutory reporting requirements on completing the questionnaire. When the number of sources to be recontacted is small, the information can be obtained through telephone contacts or plant visits. If the source refuses to complete the questionnaire, the agency may (1) take legal action to force a response, or (2) estimate a crude emission level based on activity levels or number of employees.

Recontacting activities should begin two to four weeks after the questionnaires are mailed. Telephone calls are advantageous when recontacting sources in that direct verbal communication is involved and additional mailing costs can be avoided. Caution is urged that, when making extensive telephone contacts, the agency observe all Federal, state, or other applicable clearance requirements. A second followup mailing may be necessary if a large number of sources must be recontacted. In either case, recontact should be completed 12 to 16 weeks after the first mailing.

3.3 PLANT INSPECTIONS

Plant inspections are another technique commonly used to gather data for the point source inventory.. During plant inspections, agency personnel usually examine the various processes at a particular facility and interview appropriate plant personnel. If the agency's resources permit, source testing may be conducted as a part of the plant inspection. Because plant inspections are generally much more time consuming than questionnaires, they are usually performed only at major point sources.

Plant inspections may constitute either the initial contact an agency has with a source or, alternatively, they can be used as a method of recontacting sources either to obtain additional information or to verify data that were submitted in the questionnaire. In either case, the goal of plant inspections is to gather source data not ordinarily obtainable through other means. The major advantage of the plant inspection is that it may provide more thorough and accurate information about an emitter than does the questionnaire alone. In addition, errors resulting from a source's misinterpretation of the questionnaire, or the agency's misinterpretation of the response, are avoided. Finally, in cases where a process is unique or complex, the only realistic way for the agency to gain an adequate understanding of the emitting points and the variables affecting emissions is to observe the plant equipment personally and to go over the operations and process schematics with the appropriate plant personnel.

However, the point source questionnaires should not be completed during a plant inspection. Plant managers and engineers usually do not have immediate access to data on equipment specifications, process rates, or solvent purchases. Plant personnel need time prior to and following the plant visit to assemble materials necessary to complete questionnaires. For these reasons, the agency should make an appointment with the plant personnel and provide the plant manager with questionnaires prior to an inspection.

The data that are acquired in the plant inspection are basically the same as are solicited in a questionnaire. Generally, more data may be obtained than would normally be requested on the questionnaire, such as plant flow diagrams, logs of various process variables, photographs of various emission points, and control device characteristics. Naturally, if the plant has source test data for processes within the facility, the agency should obtain test results for use in the inventory. The agency should review any source test data supplied by a particular plant before using in the inventory to make sure that acceptable sampling and analytical procedures were employed and that the test conditions were reasonably representative of the time period covered by the inventory.

Special plant inspection forms may be developed to help the agency conduct the plant visit. Because of the extra resources required, such forms should be developed only when many plant inspections are anticipated, when certain major sources are prevalent, and when the same kind of information will be requested during each visit. This latter condition may not hold in situations where the agency is using the plant inspection as a followup to the questionnaire.

3.4 OTHER AIR POLLUTION AGENCY FILES

During the point source data collection effort, the agency should consider using information included in its own permit and/or compliance files. Permits are typically required for construction, start up, and continuing operation of an emission source. Permit applications generally include enough information about a potential source to describe the nature of the source as well as to

estimate the magnitude of emissions that will result from its operations. The inventory effort should make maximum practical use of information in permit files. At least, the permit application file can be used for the development of the mailing list or for determining the need for a plant inspection or telephone contact when the source comes on line.

Another type of file that may be maintained by some agencies is the compliance file. A compliance file is a record of the agency's dealing with each source on enforcement matters. For example, a compliance file might contain a list of air pollution regulations applicable to a given source, a history of contacts made with that source on enforcement matters, and an agreed-upon schedule for the source to effect some sort of control measures. Because the compliance file will usually contain basic equipment information as well as baseline emissions data, it can be a useful tool in the inventory effort. Again, at a minimum, each source in the compliance file should be a candidate for the emission inventory, especially if an SIC code indicates that a source is a potential source of VOC emissions.

The agency should consult both permit and compliance files when developing projection inventories. The information therein on proposed new facilities or control device applications on existing facilities will be useful to the agency in determining baseline projection year emissions.

3.5 PUBLICATIONS

Another approach to collecting point source data is to use information found in selected publications. The term "publication" in this context refers to any industrial and governmental file, periodical, list, or report that contains information on process descriptions, activity levels, or control devices for various kinds of sources, either individually or collectively. Publications are primarily used to obtain activity level information on area sources, although to some extent, they can also be employed for point sources. The types of reports that are useful in this method include census reports, chemical business surveys, marketing reports, trade association journals, and energy and fuel consumption reports. As a specific example, Federal Power Commission Form 67[21] contains data sufficient to make estimates of VOC emissions from fossil fuel-fired power plants. As another example, Post's Pulp and Paper Directory[22] contains equipment and production information with which to estimate approximate emissions from pulp mills. Periodicals such as The Oil and Gas Journal[23] and Chemical and Engineering News[24] intermittently list summary information on individual refineries and chemical manufacturing operations that can also be used to generate emission estimates. Most of these publications will not provide emission data. Instead, emissions should be estimated through use of appropriate activity level emission factors or emissions-per-employee factors.

As a rule, emission estimates based on publications should be used only for point sources where a questionnaire is not received, where no plant contact can be made, or where it is necessary to get individual estimates of an emission potential. In these circumstances, the agency should consider use of publications to obtain individual point source data as a default mechanism to

be employed only if the other approaches described in this document cannot be used. Often, the most appropriate use of such publications is to help the agency in the development of the point source mailing list. In certain instances, publications can also be useful in determining collective estimates of total capacity, production, number of employees, and planned expansion associated with particular industries. This collective information can aid the agency in scaling up the inventory to account for missing sources.

3.6 EXISTING INVENTORIES

The agency should examine any available inventory that may exist for the particular area of concern before electing to employ one or several of the data gathering approaches detailed in the previous sections,. If an inventory of VOC or any other pollutant has been compiled, and either is well-maintained or was initially well-documented, many of the data elements therein can be used directly in a new emission inventory. In many cases, the existing point source information can be made current simply by telephone calls, personal visits, or through the use of abbreviated questionnaires. A limited number of contacts will minimize the effort that both the source and the agency must expend in updating the inventory data base.

If the existing inventory is computerized, a retrieval program can be developed which prints out letters and questionnaires. The questionnaires could contain existing inventory data on each source and could ask the source operators to verify or to correct the information. Such a verification form could be used with telephone contacts or plant visits. This approach should reduce the time needed to conduct an inventory and should ease the paperwork burden of the source.

One point should be stressed if an existing inventory is employed. If the inventory that is used as a starting point in the current effort was not conducted primarily for VOC, a number of major VOC emitting sources may be either omitted from such an inventory or treated collectively as area sources because their emissions of other pollutants are negligible. Hence, the agency should consider the possibility that additional sources may have to be included. Conversely, there may be many sources in an existing inventory that are considered major sources of some other pollutant but not necessarily of VOC, NO_x, or CO. Care should be taken in this latter instance that a significant quantity of resources is not expended in soliciting additional information from those sources that are not significant emitters of the pollutant(s) under consideration.

3.7 RULE EFFECTIVENESS (RE)

Past inventories have assumed that regulatory programs would be implemented with full effectiveness, achieving all of the required or intended emission reductions and maintaining that level over time. However, experience has shown regulatory programs to be less than 100 percent effective in most source categories in most areas of the country. The concept of applying RE in the SIP emission inventory has evolved from this observation. In short, RE reflects the ability of a regulatory program to achieve all the emission

reductions that could be achieved by full compliance with the applicable regulations at all sources at all times.

Several factors should be taken into account when estimating the effectiveness of a regulatory program. These include: (1) the nature of the regulation (e.g., whether any ambiguities or deficiencies exist, whether test methods and/or recordkeeping requirements are prescribed); (2) the nature of the compliance procedures (e.g., taking into account the long-term performance capabilities of the control); (3) the performance of the source in maintaining compliance over time (e.g., training programs, maintenance schedule, recordkeeping practices); and (4) the performance of the implementing agency in assuring compliance (e.g., training programs, inspection schedules, follow-up procedures).

In the proposed post-1987 ozone/carbon monoxide policy, it was stated that a factor of 80 percent should be used to estimate RE in the base year inventories. The final policy will similarly contain the 80 percent default value, but will also give states the option to derive local category-specific RE factors within some tightly prescribed guidelines as EPA deems appropriate. Whichever option is exercised to estimate RE, the results of a local source-by-source evaluation performed for a particular source category according to the protocol published by the Stationary Source Compliance Division will override estimated factors.

In the SIP inventory, the RE determined for the source category should be applied to all sources in the category with the following exceptions: (1) sources not subject to the regulation; (2) sources achieving compliance by means of an irreversible process change that completely eliminates solvent use; and (3) sources for which emissions are directly determined by calculating solvent use over some time period and assuming all solvent was emitted from the source during the time period.

The RE factor should be applied to the estimated control efficiency in the calculation of emissions from a source. An example of the application is given below.

Uncontrolled emissions = 50 lbs/day

Estimated control equipment efficiency = 90%

Rule effectiveness = 80%

$$\text{Controlled emissions} = 50\,[1 - (0.90)(0.80)]$$

$$= 50\,[1 - 0.72]$$

$$= 14 \text{ lbs/day}$$

Thus, the application of RE results in a total emission reduction of 72 percent.

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4.0 AREA SOURCE DATA COLLECTION

4.1 INTRODUCTION

The area source inventory enables an agency to estimate emissions collectively for those sources that are too small and/or too numerous to be handled individually in the point source inventory. While the VOC sources are generally small sources and are usually associated with solvent use, most NO_x and CO sources are large and are associated with combustion. Considerable attention should be given to the area source inventory, as significant quantities of VOC emissions will generally be associated with the important area source categories. Historically, emissions from area sources have been underestimated because of either the lack of appropriate inventory procedures or little emphasis on obtaining area source data. This chapter provides several approaches to collecting data at the county or equivalent level, from which annual or seasonal area source estimates can be derived. In addition, procedures are presented to account for emissions from source categories which have been often overlooked in previous VOC emission inventories.

4.1.1 AREA SOURCE INVENTORY STRUCTURE AND EMPHASIS

Table 4.1-1 lists those categories that are inventoried primarily as area sources in a VOC emission inventory. (SIC codes for these sources are available in Table 7.2-1.) Sources listed in Table 2.2-1 which are not in Table 4.1-1 and are below the point source inventory cutoff can also be tabulated collectively and reported as area sources. The importance of area source categories may vary from area to area. For certain areas, inventories may need to include the resources of local importance or define additional subcategories. The area source categories in Table 4.1-1 can be divided into two broad groups characterized as evaporative emissions or fuel combustion emissions. Most evaporative emission sources, with the exception of service stations, are characterized by some type of solvent use. Service stations emit gasoline vapors as a result of various loading and fueling operations.

As is discussed in more detail in subsequent sections of this chapter, some of the source categories in Table 4.1-1 will usually be handled entirely as area sources. However, some source categories will be handled only partially as area sources if a number of the facilities in those categories is large enough for individual treatment as point sources. Care is needed not to double count a source's emissions in both the point and area source inventories. Area source emission totals should be adjusted downward to reflect emissions included in the point source inventory.

Another important consideration in preparing an area source inventory is the extent to which a regulation may cover emissions from the source category. The "top down" approaches discussed in the next section do not contain specific instructions on how to account for emission reductions expected to result from application of a regulation. When estimating emissions using these area source methodologies, agencies should be careful to incorporate an estimate of rule penetration by means of the following formula:

TABLE 4.1-1. AREA SOURCES OF VOC EMISSIONS

Evaporative Loss -

Gasoline Distribution
- Tank truck unloading (Stage I)
- Vehicle fueling (Stage II)
- Underground tank breathing
- Gasoline tank trucks in transit

Stationary Source Solvent Use
- Dry cleaning
- Degreasing, small industrial/commercial
  - Open top vapor and conveyorized
  - Cold cleaning
- Surface coating
  - Architectural
  - Automobile refinishing
  - Other small industrial
- Graphic arts
- Cutback asphalt paving/asphalt cement
- Asphalt roofing kettles and tankers
- Pesticide application
- Commercial/consumer solvent use

Waste Management Practices
- Publicly owned treatment works (POTWs)
- Hazardous waste treatment, storage, and disposal facilities (TSDFs)
- Municipal and other nonhazardous waste landfills

Leaking Underground Storage Tanks

Combustion -

Highway Mobile Sources
- Light duty vehicles (LDV)
- Light duty gasoline powered trucks <6000 lbs (LDT1)
- Light duty gasoline powered trucks 6000-8500 lbs (LDT2)
- Heavy duty gasoline powered trucks (HDG)
- Heavy duty diesel powered trucks (HDD)
- Motorcycles

Stationary Source Fossil Fuel Use (by fuel type)
- Residential
- Commercial/institutional
- Industrial

TABLE 4.1-1. AREA SOURCES OF VOC EMISSIONS (continued)

Nonhighway Mobile Sources
- Aircraft
  - Military
  - Civil
  - Commercial
- Railroad locomotives
- Vessels
- Off-highway vehicles
  - Off-highway motorcycles
  - Farm equipment
  - Construction equipment
  - Industrial equipment
  - Lawn and garden equipment
  - Snowmobiles

Solid Waste Disposal
- On-site incineration
- Open burning

Other Sources
- Forest Fires
- Slash burning/prescribed burning
- Agricultural burning
- Orchard heaters

$$\frac{\text{Uncontrolled emissions covered by the regulation}}{\text{Total uncontrolled emissions}} \times 100 \text{ percent}$$

Once uncontrolled emissions and rule penetration are determined, RE should be applied as discussed previously in Section 3.7. An example of how to incorporate both penetration and RE in the same source category is presented in Section 6.4.

The selection and structuring of area source categories are important aspects of the planning process which affect the resources required for inventory completion as well as the inventory's usefulness in the agency's ozone control program. Generally, highway vehicles will be the largest VOC emitting category and should be emphasized accordingly. All of the evaporative loss sources may be important, especially those covered by Control Techniques Guidelines (CTGs). Special attention should be given to these VOC sources as well.

Because an important use of the inventory is to study the effects of applying various control measures, the area source categories should be defined so that emission reductions from anticipated controls on area sources can be readily summarized from the data maintained in the area source files. For example, if the effect of vapor recovery on tank truck unloading emissions at service stations (Stage I control) is to be evaluated, then emissions from these operations should be distinguished from vehicle fuel tank loading (Stage II operations) emissions. As another example, in order to estimate the effect of RACT on dry cleaning plants, data for systems using perchloroethylene should be maintained separately from those for sources using petroleum (Stoddard) solvents because of the different control technologies that may be applied to each system. Judicious definition of area source categories will also help the agency exclude nonreactive compounds from the emission totals. In this regard, if separate emission totals are maintained for different solvents in the inventory, most of the nonreactive halogenated solvents can be readily identified.

4.1.2 SOURCE ACTIVITY LEVELS

Area source emissions are typically estimated by multiplying an emission factor by some known indicator of collective activity for each source category at the county (or equivalent) level. An activity level is any parameter associated with the activity of a source, such as production rate or fuel consumption, that may be correlated with the air pollutant emissions from that source. For example, the number of landings and takeoffs (LTO) provides an estimate of aircraft activity at an airport. In this example, the number of LTOs can be multiplied by appropriate emission factors to estimate airport emissions. As another example, the total amount of gasoline handled by service stations in an area can be used to estimate evaporative losses from gasoline marketing. In this case, to estimate total emissions from this source category, the gasoline handling activity can be multiplied by an emission

factor representing all of the individual handling operations at each service station.

4.1.3 METHODS FOR ESTIMATING AREA SOURCE ACTIVITY LEVELS AND EMISSIONS

Several methodologies are available for estimating area source activity levels and emissions. Estimates can be derived by (1) treating area sources as point sources, (2) surveying local activity levels, (3) apportioning national or statewide activity totals to local inventory areas, (4) using per capita emission factors and (5) using emissions-per-employee factors. Each approach has distinct advantages and disadvantages when used for developing emission estimates, as discussed below.

1. Applying point source methods to area sources - Small sources that would normally be treated as area sources may be handled as point sources for several reasons. For example, collective activity level estimates may not be readily determinable for certain source categories.

In other cases, sufficient data may be available on individual sources to allow the agency to estimate activity levels and emissions for each facility. For example, records may be available from another agency that show the location and amount of solvent handled by each dry cleaner within the inventory area; in which case, the inventorying agency may calculate emissions for each plant. At this point, the agency must decide whether an individual point source record will be coded and maintained for each facility or whether the resulting individual activity levels and emission estimates will be handled collectively in the area source inventory. This decision will depend on the resources available for the point source inventory and whether the agency elects to handle sources individually or collectively in the projection year inventory. In this latter regard, more accurate projections will result if sources are treated as point sources, because individual control reductions can be estimated for each facility.

2. Local activity level surveys - In some instances, collective activity level estimates for a given category may be available from a local source. For example, local trade associations may have data on the amount and types of architectural surface coating, or the amount and types of dry cleaning solvents used in an area. Tax, highway, energy, and other state or local agency records may provide collective activity level estimates for other area source categories, including gasoline sales and cutback asphalt use. Hence, the inventorying agency should survey various local associations and agencies to determine what information is maintained for the area that can be used in the area source inventory. Specific associations or agencies that may be contacted for selected area source activity level information are suggested in the following sections of Chapter 4.

3. Apportioning state or national totals to the local level - If countywide activity level information is not available locally, state totals may be apportioned to compute local estimates. For example, the quantity of fuel used in railroad locomotives is generally available at the state level from the Department of Energy. Fuel use can be approximated at the local level

by apportioning statewide fuel use to the county level on the basis of miles of track per county. Residential, commercial, and industrial fuel consumption are other categories that are commonly handled in this manner. Major drawbacks of this approach are that additional data and resources are needed to apportion activity level estimates to the local level, and accuracy is lost in the process. If state level data are not available and no alternatives are accessible, then national data may have to be apportioned to the local inventory area. However, apportioning national data to the local level is generally less accurate than most available methods and should be done only when absolutely necessary.

The National Air Data Branch of EPA uses state and national totals from various available publications to estimate area source emissions at the county level for NEDS. Those interested in obtaining NEDS emission estimates for particular area sources in specific counties should contact their EPA Regional Office or the National Air Data Branch, MD-14, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. In general, these NEDS area source estimates will not be as sensitive to local conditions as estimates made by an agency using locale-specific information. The techniques used in NEDS for developing area source estimates are described in References 1-3.

4. Per capita emission factors - Sources in certain area source categories are not only numerous and diffuse, but are difficult to inventory by any of the above procedures. As an example, solvent evaporation from consumer and commercial products such as waxes, aerosol products, and window cleaners can neither be routinely determined by the local agency for many local sources, nor will any kind of survey that will yield such information generally be possible. The use of per capita factors is based on the assumption that, in a given area, emissions can be reasonably associated with population. This assumption is valid over broad areas for certain activities such as dry cleaning, architectural surface coating, small degreasing operations, and solvent evaporation from household and commercial products. Per capita factors for these categories are suggested in the following sections of this chapter. Per capita factors should not be developed and used indiscriminately for sources whose emissions do not correlate well with population. Large, concentrated industries, such as petrochemical facilities, should not be inventoried using per capita factors.

5. Emissions-per-employee factors - This approach is conceptually equivalent to using per capita factors, except that employment rather than population is used as a surrogate activity level indicator. Emissions-per-employee factors are used usually to estimate emissions for those source categories for which a Standard Industrial Classification (SIC) code has been assigned and for which employment data (typically by SIC) at the local level are available. Generally, this involves SIC categories 20-39, as shown in Table 3.1-1 of Chapter 3. Since, in most cases, a large fraction of VOC emissions within SICs 20-39 will be covered by point source procedures, the emissions-per-employee factor approach can be considered a backup procedure to cover emissions from sources that are below the point source cutoff level. This approach can also be used where the agency surveys only a fraction of the area sources within a given category. In this case, employment is used as an

indicator to "scale up" the inventory to account collectively for missing sources and emissions in the area source inventory. Parameters other than employment, such as sales data or number of facilities, can be used to develop emission estimates. However, employment is generally the most readily available parameter. Scaling up is discussed in detail in Chapter 6.

4.1.4 CONTENTS OF CHAPTER 4

The remainder of this chapter discusses specific methodologies that may be used to determine emissions for the more important source categories shown in Table 4.1-1 except for mobile sources. Agencies will be referred to other documents for guidance on inventorying highway and nonhighway mobile sources (see Section 4.7). In each case, alternative approaches that vary in complexity, cost, and the accuracy of the resulting emission totals are presented. Although certain approaches may be recommended, local data may suggest the use of alternative procedures in a given situation.

4.2 GASOLINE DISTRIBUTION LOSSES

A generalized flowchart of gasoline marketing operations is shown in Figure 4.2-1. This flowchart depicts the operations typically involved in transporting gasoline from refineries to final consumption in gasoline powered vehicles. As indicated in Figure 4.2-1, evaporative emissions occur at all points in the distributive process. The operations generally inventoried as area sources are gasoline dispensing outlets and gasoline tank trucks in transit. Bulk terminals and gasoline bulk plants, which are intermediate distribution points between refineries and outlets, are usually inventoried as point sources.[4] Most gasoline dispensing outlets emit less than 10 tons VOC per year and therefore are generally inventoried using area source methods.

VOC emissions from gasoline dispensing outlets result from vapor losses during tank truck unloading into underground storage tanks, vehicle fueling, and underground storage tank breathing. Evaporative losses from each of these activities in this source category should be tabulated separately, so that various control reduction measures may be evaluated readily. EPA has made available Control Techniques Guidelines (CTG) for Stage I operations covering gasoline vapors emitted during storage tank filling.[5]

Service stations traditionally have been the primary retail distributors for gasoline. Gasoline can be purchased from other types of businesses or stores, such as auto repair garages, parking garages, and convenience stores. In addition, gasoline may be distributed to vehicles through various nonretail outlets. Because outlets other than service stations account for roughly a quarter of all gasoline handled, care should be taken that all gasoline outlets are covered in the area source inventory.[4,5]

4.2.1 DETERMINING GASOLINE SALES

Area source gasoline evaporative losses can be inventoried in several ways. The most accurate approach is to acquire gasoline sales data, which can be multiplied by a composite emission factor to determine evaporative losses.

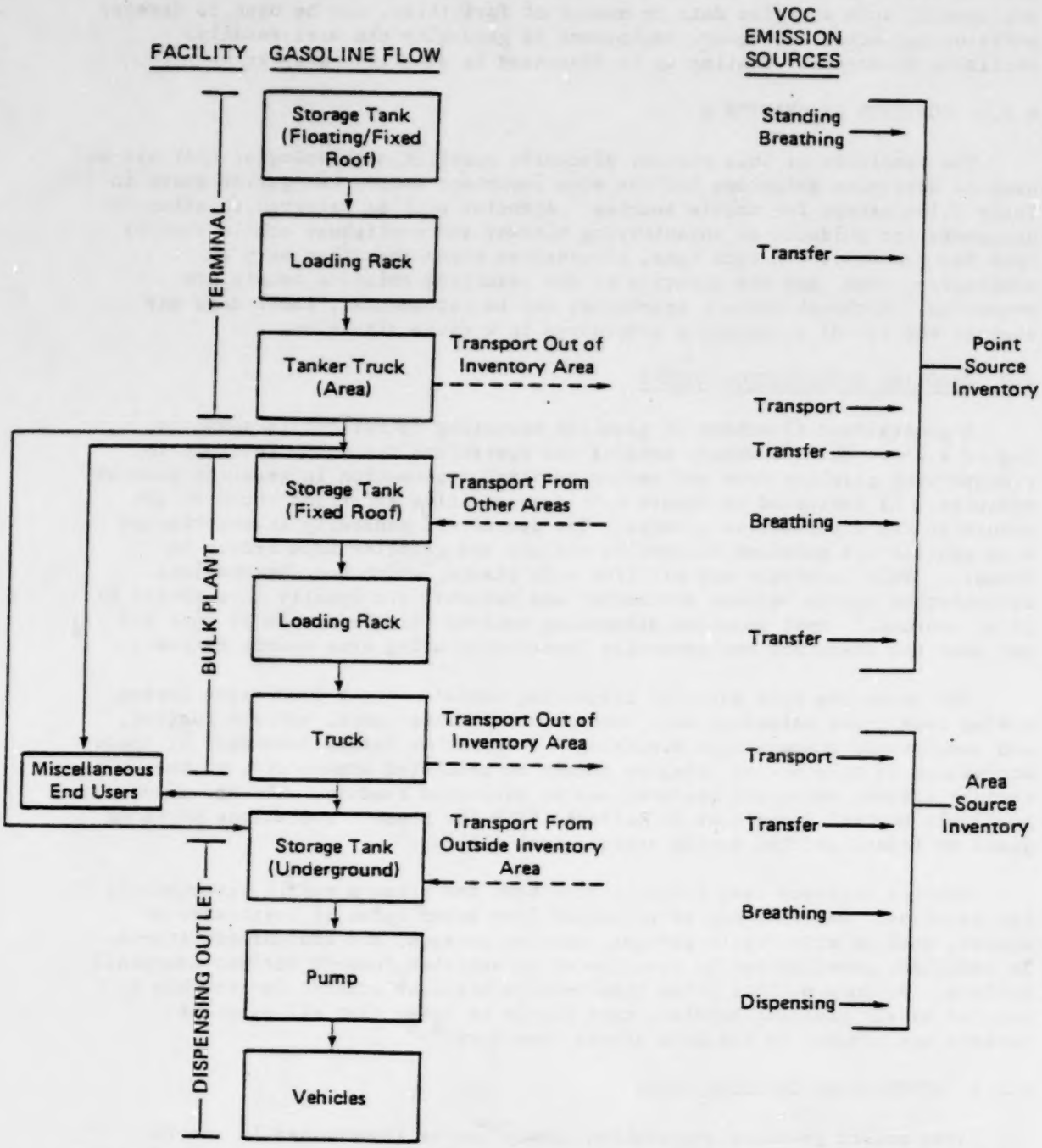


Figure 4.2-1. Gasoline marketing operations and emission sources.[4]

Gasoline sales statistics are collected and maintained by petroleum distributors and state motor vehicle and fuel tax offices, as well as federal and local government agencies involved in transportation planning and energy management. The statistics are developed from delivery records which are collected from drivers, compiled, and sent to petroleum company accounting offices. These statistics are summarized by county or other local political jurisdictions and are forwarded to the state tax office.[6] Thus, as the tax is collected per gallon sold, the actual total gasoline consumption within a jurisdiction can be back-calculated with the tax formulas. Calculation of fuel consumption from fuel tax data may already be done in some transportation planning agencies. Once derived, tax-calculated consumption should be cross-checked with data from associations of service station owners and operators, oil company distributors, jobbers, and other local sources.[7] Cross-checking is important, since gasoline for nonhighway uses and gasoline distributed to government agencies may not be taxed. Therefore, care should be taken that all gasoline consumed in the inventory area is accounted for, including that dispensed at marinas, airports, military bases, and government motor pools, as well as service stations.

Gasoline distributors may be able to provide consumption data on these sources. However, direct contact with a possible source is often the only viable way to determine gasoline consumption from the nonhighway sources of gasoline evaporation. Also, when using fuel tax data to determine gasoline consumption, exclude diesel fuel and any other fuel of low volatility from consideration.

Several less desirable alternatives exist for obtaining estimates of gasoline sales in an area. Questionnaires have been used in some instances as a means of obtaining information on each facility. Information collected in such a questionnaire could include not only the quantity of gasoline which is dispensed over a given year or season, but also the type of equipment used and the number of employees at the station. While this type of direct plant contact is potentially more accurate because information can be obtained on the type of filling and the existence of controls at each station, the use of questionnaires does involve several drawbacks. A major obstacle is the sheer number of stations usually present in most areas. In addition, because of the rapid rate at which stations open and close or change locations, a current list of sources may be difficult to define. Moreover, since many stations invariably will not respond to the questionnaires, the inventory will have to be scaled up to account for the missing stations. Scaling up can be accomplished using either employment in SIC 5541 or the number of gasoline stations as a indicator of coverage. Scaling up is discussed in Section 6.4.

Contacting distributors of gasoline through questionnaires or telephone calls has been discussed as a possible method of checking gasoline consumption obtained through tax records. However, while contacting distributors is a direct source of consumption data, it can be difficult if there is (1) a large number of distributors, (2) distribution areas which overlap the inventory boundaries, or (3) a lack of cooperation by the distributors. Fuel tax data should be easier to obtain in most areas and are therefore preferred over direct contacts to gasoline distributors.

Another alternative for estimating gasoline consumption is to use data from various national publications. For example, FHWA's annual publication, Highway Statistics, contains gasoline consumption data for each state.[8] Countywide estimates can be determined by apportioning these statewide totals by the percent of state gasoline station sales occurring within each county. Countywide service gasoline sales data are available from the Bureau of the Census' Census of Retail Trade.[9] (Note: Data in the Census of Retail Trade are usually too old to use directly in estimating countywide sales; however, they are useful in allocating other data to the county level.) Other apportioning variables, such as registered vehicles or VMT, can be used if the local agency feels that their use results in a more accurate distribution of state totals at the county level. These apportioning procedures are used in EPA's National Emissions Data System (NEDS) to estimate emissions for gasoline service stations. Even if the agency uses local sales data in the area source inventory, this approach should be used as a cross-check of the local consumption estimates. One distinct advantage of using data in Highway Statistics is that sales are tabulated by month which facilitates a seasonal adjustment of the gasoline station emission totals.

Another method of estimating gasoline sales is to use VMT data available as a result of the ongoing transportation planning process. This alternative is not generally recommended for several reasons. First, it requires local information on both the percent of VMT attributable to diesel versus gasoline fuel and the average miles-per-gallon fuel efficiency of the gasoline powered motor fleet. None of these data may be available locally, and the use of nationwide averages may introduce errors in certain applications. Moreover, highway travel will not account for all gasoline sold at various off-highway applications. Hence, because less data-intensive and more accurate procedures are usually available in any area to estimate gasoline sales, the VMT based approach generally should not be considered.

Using state or local air pollution permit files for inventorying gasoline dispensing outlets is not likely to be an effective alternative. Permit information is not usually collected because of the large number of stations and because each station's emissions are much lower than traditional point source cutoff levels. Registration systems are being attempted in some states whereby major retail chains are required to compile and submit service station lists.[6] Generally, such a detailed approach is not warranted when gasoline distribution data will yield adequate emission estimates.

4.2.2 ESTIMATING GASOLINE DISTRIBUTION EMISSIONS

Whatever approach is used to account for gasoline consumption, the flow of gasoline through the inventory area should be mapped. The best approach is to develop a chart depicting overall gasoline flow within the geographical area in question, from the point of entry, through bulk storage, to service stations and vehicle loading operations. Figure 4.2-1 can serve as the basis for such a flowchart. Construction of this flowchart provides a valuable overview of the gasoline distribution system and facilitates detection of gross anomalies in the distribution data.

Once an estimate of total gasoline sales is made, gasoline dispensing emissions can be estimated using the average emission factors shown in Section 4.4 of AP-42.[10] To facilitate the subsequent development of control strategy estimates, separate subcategories should be maintained for (1) tank truck unloading, (2) vehicle fueling, (3) underground tank breathing, and (4) tank trucks in transit. When evaluating control scenarios, tank truck unloading and vehicle refueling are defined respectively as Stage I and Stage II controls. A detailed description of gasoline marketing operations is available in Reference 4.

4.2.2.1 Tank Truck Unloading (Stage I)

Emissions from tank truck unloading are affected by whether the service station tank is equipped for submerged, splash, or balance filling. Therefore, information must be obtained on the fraction of stations using each filling method. A weighted average emission factor can then be based on the quantity of gasoline delivered by each method. A survey of several service stations in the area will produce an estimate of the number of stations employing each filling method. Trade associations are another source of information on station characteristics. Information from major brand owner/operators may also be readily available but should be used with care, as company policy may direct the use of certain equipment not representative of all stations within an inventory area.

4.2.2.2 Vehicle Fueling and Underground Tank Breathing

Losses from vehicle fueling, including spillage, and from underground tank breathing are determined by multiplying gasoline throughput by the appropriate AP-42 emission factors. Gasoline sales data can be used as a collective measure of gasoline throughput. Determining which service stations have vehicle refueling (Stage II) emission controls is important in projection year inventories. If Stage II controls are planned in a projection year, a composite emission factor will have to be determined representing the mix of controlled and uncontrolled refueling operations in the area. At present, Stage II controls are not widely implemented. Underground tank breathing may be affected by Stage II controls but is unaffected by Stage I controls.[4]

4.2.2.3 Losses from Gasoline Tank Trucks in Transit

Breathing losses from tank trucks during the transport of gasoline are caused by leaking delivery trucks, pressure in the tanks, and thermal effects on the vapor and on the liquid. A worst case situation arises if a poorly sealed tank has been loaded with gasoline and pure air becomes saturated. During the vaporization process, pressure increases and venting occurs.[4]

Emission factors for gasoline trucks in transit are given in Section 4.4 of AP-42. These factors are given in terms of $lb/10^3$ gallons of gasoline transferred in two modes: (1) tanks loaded with fuel and (2) tanks returning with vapor. For convenience, these factors may be added and applied to each round trip delivery.

Because some gasoline is delivered to bulk plants rather than delivered directly to service stations from bulk terminals, the amount of gasoline transferred in any area may exceed the total gasoline consumption, due to the additional trips involved. Therefore transit emissions involve not only end consumption but also gasoline transport from outside the inventory area to the intermediate bulk plants, and should be based on total gasoline transferred rather than on consumption. As an example, if gasoline sales in an area are 300 million gallons per year, and 50 million gallons of this goes through bulk plants, then 350 million gallons is the amount transported by tank trucks and is the appropriate figure to use to estimate transit losses. A nationwide average of roughly 25 percent of all gasoline consumed goes through bulk plants.[4] Hence, gasoline distribution in an area could be multiplied by 1.25 to estimate gasoline transported. Because this percentage will vary so much from area to area, the amount of gasoline handled by bulk plants should be obtained from the point source inventory to be used in making this adjustment.

One method which can be used to account for bulk-plant handling involves contacting local air agencies to determine the throughput at bulk plants. If, for example, a small percentage of gasoline passes through bulk plants in the area under consideration, this additional gallonage would be added to the annual consumption. Emissions from tank trucks in transit, however, will generally be minimal in most areas. Hence, a great deal of effort is not warranted in making this adjustment.

4.3 STATIONARY SOURCE SOLVENT EVAPORATION

Solvents are any liquid organic compounds (or groups of compounds) that are used to dissolve other materials. Solvent use can be broadly classified into two categories: (1) cleaning, including degreasing and dry cleaning, and (2) product application, such as surface coating, printing, and pesticides, where the solvent serves as a vehicle for the product being applied. Each of these two types of solvent use results in some or all of the solvent being evaporated into the atmosphere.

The widespread use of solvents in all sectors of the economy makes inventorying VOC emissions a difficult task. The most accurate means to account for solvent use in the inventory is to identify as many sources as possible using the point source methods in Chapter 3. Unfortunately, because so many small solvent users are present in most, especially urban, areas, all of these small sources cannot be economically handled as point sources. Hence, area source procedures are necessary to include these small solvent users in the VOC inventory. The source categories covered in Section 4.3 are shown in Table 4.1-1. In certain areas, other solvent evaporation sources may be of local importance, and should be included in the area source inventory.

4.3.1 DRY CLEANING

Dry cleaning operations vary in size, type of service, and type of solvent used. Industrial, commercial, and self-service facilities clean not only personal clothing, but also uniforms, linens, drapes, and other fabric

materials. Three basic solvent types are used in dry cleaning: petroleum (Stoddard), perchloroethylene ("perc"), and trichlorotrifluoroethane (Freon 113 or FC 113). Perchloroethylene is used in approximately 80 to 90 percent of all dry cleaning establishments and constitutes about 70 percent of all cleaning solvent consumed. Almost all other establishments use petroleum solvent. Fluorocarbons represent only a small percentage of dry cleaning solvent use.[15-18]

VOC emissions from dry cleaning vary with the type of process and solvent used. Perchloroethylene systems emit less VOC for a given quantity of clothes cleaned due to the higher cost of synthetic solvents, while petroleum solvent operations typically have greater evaporative losses. VOC emissions occur mainly from the dryer and the filter muck treatment systems. Miscellaneous fugitive losses occur from valves, flanges, and seals as a result of poor maintenance. Detailed process descriptions and information on emissions and controls can be obtained from References 16 and 17 as well as AP-42.

Both point and area source methods can be used to inventory dry cleaners. Industrial dry cleaning is done at large plants whose emissions will often exceed 100 tons of VOC per year and should be inventoried by point source procedures described in Chapter 3.

Commercial and self-service dry cleaning facilities typically emit less than 10 tons per year, and large numbers of these facilities may operate within an urban area. A number of area source methods may be used in conjunction with point source procedures to inventory commercial and self-service dry cleaning emissions. Optimally, all plants may be handled using point source procedures. The easiest way to accomplish this is to send brief survey forms to each plant or to a representative sample of plants identified in the yellow pages of the telephone directory. An example of such a form is shown in Appendix D. In general, all that is needed to develop an area source emission total from such a survey is information on the quantity of solvent annually consumed at every plant below the point source cutoff level. Emissions are usually assumed equal to the total quantity of makeup solvent consumption in the area. Information should also be obtained on the type of solvent used at each plant and on any control measures in place. If incineration is practiced at any petroleum plant, emissions from that plant will not be equal to makeup solvent consumption, but rather, will be reduced according to the efficiency of the control device. In contrast, when the more common nondestructive control measures are employed, such as condensers and adsorbers, emissions approximate makeup solvent consumption, because the collected solvent is cycled for reuse in the process. Because the agency may elect to send questionnaires to only a sample of dry cleaners below the cutoff level, the resulting emission totals from the point source inventory and the area source survey should be scaled up to account for missing emissions. Scaling up should be based on (1) employment within SICs 7215 (coin-operated laundries and dry cleaning), 7216 (dry cleaning and dyeing plants), and 7218 (industrial launderers) or (2) number of plants covered by the point source survey. If employment is used as the coverage indicator, the survey form should also ask for the number of employees working at each plant. Scaling up is discussed in detail in Chapter 6.

It has been suggested that SIC 7218 (industrial launderers) should not represent industrial dry cleaners as well. Communication with industrial launderers in one area (individual companies as well as the Institute of Industrial Launderers) revealed that by and large the type of cleaning agents they use are not volatile organics. The agents used are detergents or soap and water. Of the nine industrial launderers contacted, five did no dry cleaning; of those facilities that did, only 10 to 20 percent of their operation was dry cleaning in nature. In this case, SIC 7216 (dry cleaning and dyeing plants) can be used to represent commercial as well as industrial plants.

The following factors may be applied to estimate nonindustrial dry cleaning emissions within a broad area:

Commercial plants: 1.2 lb/capita/yr
Self-service (coin-op) plants: 0.3 lb/capita/yr

If any commercial or coin-op plants are known to be included in the point source inventory, the emission estimates resulting from the above per capita factors must be reduced accordingly. About 30 percent of the above per capita factor for commercial plants represents petroleum solvent whereas the remaining 70 percent of the commercial plant solvent and all of the coin-op solvent are perchloroethylene. The use of trichlorotrifluoroethane can be assumed to be nominal when applying these per capita factors.[18]

The following example illustrates the use of these factors.

<u>Example</u>: An urban area with an inventory base year population of 1,032,500 people has been inventoried by questionnaires sent mainly to large industrial dry cleaning plants. The questionnaires identified an industrial dry cleaning plant using petroleum solvent of which 102 tons were emitted during the base year. Fifteen commercial dry cleaning plants were also identified, emitting a total of 105 tons of perchloroethylene and petroleum solvents.

<u>Solution</u>: Total commercial and self-service plant emissions can be estimated by applying a per capita emission factor, as follows:

$$1{,}032{,}500 \times (1.2 + 0.3)\ \frac{\text{lb VOC}}{\text{capita/yr}} \times \frac{1\ \text{ton}}{2000\ \text{lb}} = 774\ \text{tons/yr}$$

Since 105 tons/yr of this 774 tons/yr are accounted for in the point source inventory, the resulting area source total for commercial and coin-op plants is:

$$(774 - 105) = 669\ \text{tons/yr}$$

Hence, total dry cleaning emissions for the area are:

$$669 + 105 + 102 = 876\ \text{tons/yr}$$

Note in this example that the commercial plant point source total is subtracted from the per capita derived emissions. Also, the industrial plant point source emissions are not subtracted from per capita emissions. Finally, note that these factors apply only to perchloroethylene and petroleum solvent emissions.

A small percentage of dry cleaning establishments uses trichlorotrifluoroethane (FC 113) as a fabric cleaning solvent. FC 113 is classified by EPA as a nonreactive compound. Therefore, information on the type of solvent used at each dry cleaning plant needs to be elicited during any plant contacts or surveys so that FC 113 emissions can be excluded from the SIP emissions inventory. Nationwide, FC 113 is used only in about 5 percent of the coin-operated units, accounting for only about 0.4 percent of total annual dry cleaning solvent consumption.[16] Hence, in most situations, little error is involved if all dry cleaning solvent is assumed to consist of perchloroethylene and petroleum solvents. The per capita factors recommended earlier exclude FC 113.[18]

4.3.2 DEGREASING OPERATIONS

Solvent metal cleaning or degreasing operations employ nonaqueous solvents to remove soils from the surface of metal articles which are to be electroplated, painted, repaired, inspected, assembled, or machined. Metal workpieces are cleaned with organic solvents in applications where water or detergent solutions cannot do an adequate cleaning job. A broad spectrum of organic solvents may be used for degreasing, such as petroleum distillates, chlorinated hydrocarbons, ketones, and alcohols.

There are basically three types of degreasers: small cold cleaners, open top vapor degreasers, and conveyorized degreasers. According to recent estimates, there are about 1,300,000 small cold cleaning units operating in the U.S. Seventy percent of these units are devoted to maintenance of servicing operations, including service stations, auto dealerships, and miscellaneous repair stations, while the remaining 30 percent are devoted to manufacturing operations. A typical cold cleaning unit emits approximately one third ton of VOC per year. In contrast, typical open top vapor degreasers and conveyorized degreasing units emit on average 10 and 27 tons of VOC per year respectively. These larger units are commonly used in the metal working industry. The design and operation of each of these types of degreasers will vary, as will emissions and the types of control measures used. References 16 and 20 should be consulted for detailed descriptions of processes and emissions from degreasing units.

Development of degreasing emission estimates is complicated by a number of factors. First, some degreasers will be large enough to be considered point sources, and yet, a large fraction of all degreasers will fall below any reasonable point source cutoff and thus will have to be tallied as area sources. Second, degreasing operations are not associated with any particular industrial activity. Instead, degreasing of some sort may be carried out in a wide variety of industries, including (1) metal working facilities (e.g.,

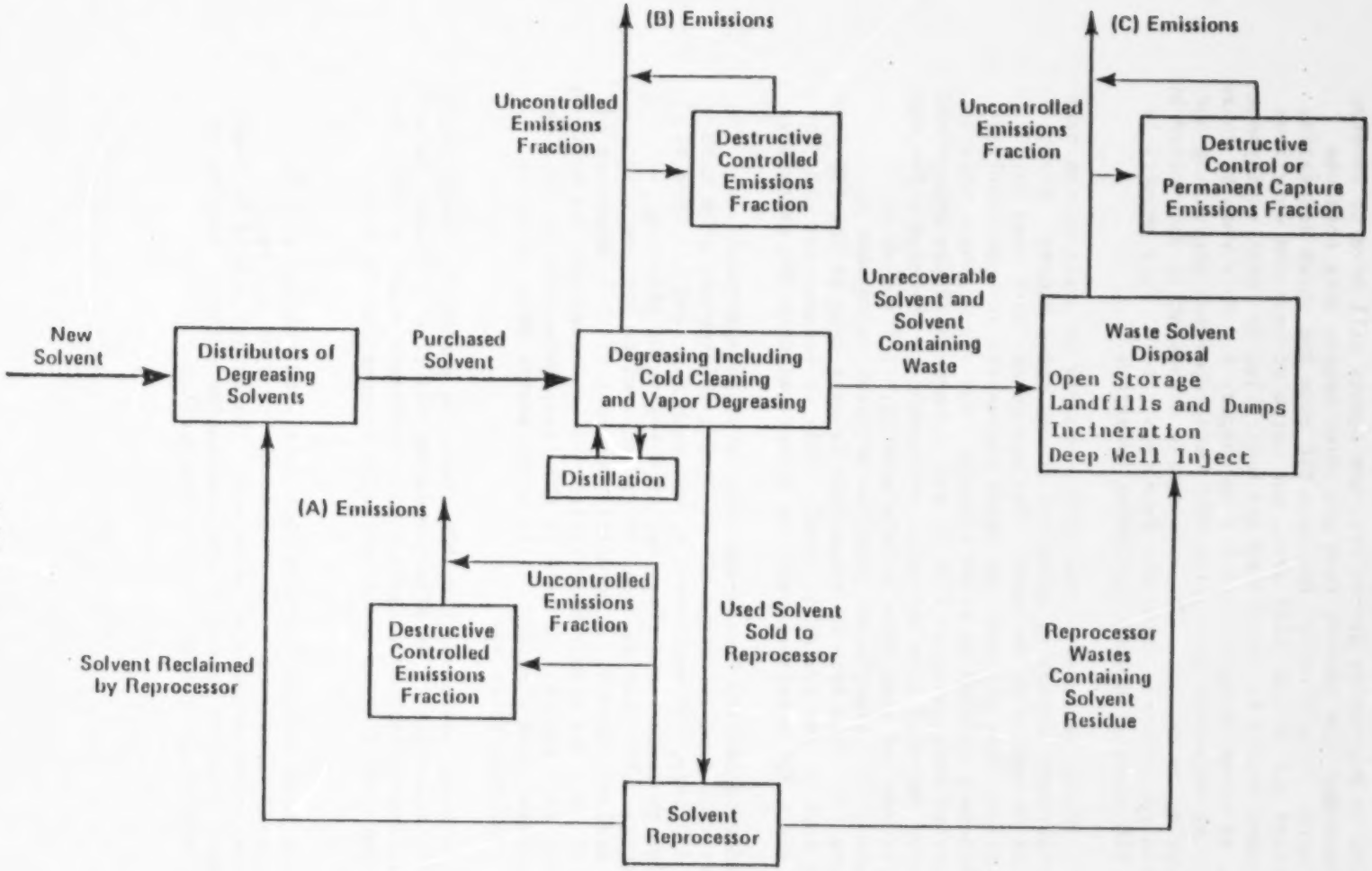
automotive, electronics, appliances, furniture, jewelry, plumbing, aircraft, refrigeration, business machinery, fasteners), (2) nonmetal working facilities (e.g., printing, chemicals, plastics, rubber, textiles, glass, paper, electric power), (3) maintenance cleaning operations (e.g., electric motors, fork lift trucks, printing presses), and (4) repair shops (e.g., automobile, railroad, bus, aircraft, truck, electric tool). Third, the practice of solvent waste reprocessing at some degreasing facilities complicates the making of material balance estimates of solvent loss. Fourth, the fact that much of the VOC emissions associated with degreasing occurs at the solvent waste disposal site complicates the location of emissions within the inventory area. Fifth, many of the solvents used for degreasing are considered photochemically nonreactive, and hence, must be excluded from the inventory totals.[19,20]

A general chart illustrating the flow of degreasing solvent in an area is shown in Figure 4.3-1. Ideally, the agency could develop an areawide estimate of total degreasing emissions from both point and area sources from the totals in this flowchart. Basically, total areawide emissions would approximately equal the amount of solvent purchased by degreasers minus that quantity of solvent sent to commercial reprocessing plants for reclamation. In practice, such a flowchart may be difficult to construct for several reasons. First, manufacturers, distributors, and commercial reprocessors may be reluctant to disclose sales information. Second, they may not know how much of their product is used for degreasing as opposed to other end uses. Third, they may be unable to determine where their product is used, especially if they are not the final distributors in the area, or if they are selling to companies located at a number of sites. Fourth, some fraction of degreasing solvent most likely will be shipped from outside the inventory area. Hence, while it is a valuable concept in understanding degreasing emissions, and a possibility in some circumstances, such a flowchart is not considered practical in most areas.

4.3.2.1 Open Top Vapor and Conveyorized Degreasing

Open top vapor degreasers and conveyorized degreasers should be handled as point sources to the extent possible, even though these units individually may not exceed the agency's point source cutoff level. General point source procedures are covered in Chapter 3. A questionnaire covering degreasing emissions is shown in Appendix D. Likewise, solvent reprocessing plants should be handled as point sources. The major advantage of handling these larger operations as point sources is that source-specific data can be elicited on the amounts and kinds of solvents consumed at each facility, as well as on the amounts of waste solvent sold for reprocessing or disposal by some other means. With this kind of detailed information, material balances can be employed to estimate degreasing emissions from each unit.

Because all open top vapor degreasers and conveyorized degreasers may not be covered in the point source inventory, procedures should be considered for scaling up to account for missing emissions. As discussed in Chapter 6, scaling up is best accomplished using employment data in appropriate SIC codes as indicators of inventory coverage. Hence, to encompass missing open top vapor degreasers and conveyorized degreasers, the agency should scale up the inventory in SIC categories 25 and 33 through 39. Because comprehensive



Total Degreasing Emissions = (A + B + C) = Σ New Solvent Produced for Degreasing = Σ Purchased Degreasing Solvent − Σ Reprocessed Degreasing Solvent

Figure 4.3-1. Mass balance of solvent used in degreasing operations.

emissions-per-employee factors are not available from the literature for scaling up emissions in degreasing operations, the agency will have to develop its own emissions-per-employee factors from the point source data obtained through plant contacts. Specifically, for each SIC code for which degreasing activities are carried out in the local area, the ratio of reported emissions to reported employment should be calculated and multiplied by total employment for each SIC code, as shown in Equation 6.6-2 in Chapter 6. This results in an estimate of area total emissions associated with open top vapor degreasing and conveyorized degreasing operations. The area source component is determined by subtracting reported point source emissions from this total. This process is repeated for each SIC associated with degreasing emissions.

Several points should be noted if the agency chooses to scale up the open top vapor and conveyorized degreasing emissions in the above manner. First, the need for scaling up should be reviewed. The agency may have made such extensive plant contacts that all open top vapor degreasers and conveyorized degreasers are adequately covered as point sources. One way to check this is to compare the reported employment in SICs 25 and 33 through 39 (as determined from the point source records) with the total employment in the county for each SIC. The latter figures are available in Reference 21. Scaling up is probably not necessary if a significant fraction of total employment is accounted for. Note that this type of comparison is best done at the SIC four digit level rather than at the two digit level. This is because not all employment in two digit SIC categories will be associated with VOC emissions.

Second, in order to develop locale-specific emissions-per-employee factors, the agency will need to obtain the following information from each point source: (1) SIC code, (2) employment within each SIC, and (3) type of degreasing operation employed (cold cleaning, open top vapor cleaning, or conveyorized cleaning). The last delineation is required to exclude cold cleaning from the derived factors. A potential drawback of this procedure is that the quantity of data the agency must collect is increased and the data may not be available for each source. If this is the case, emissions-per-employee factors can be developed from a subset of the point source data for which adequate data are available to do so.

Third, only photochemically reactive VOC should be scaled up. Information on solvent type will also have to be elicited during the plant contact, so that any resulting emissions-per-employee factors only represent reactive VOC. See Section 6.5 for a detailed discussion on excluding nonreactive VOC from emission totals.

These preceding three points indicate that data requirements will be substantially increased if scaling up is to account for open top vapor degreasing and conveyorized degreasing emissions. The agency should be aware of these requirements from the outset of the compilation effort. Scaling up cannot be accomplished if the proper data are not available.

4.3.2.2 Cold Cleaning Degreasing

The best alternative for estimating total areawide degreasing emissions is to apply a per capita factor to cover small cold cleaning operations and to handle larger vapor degreasers as point sources. A factor of 3 lb/capita/year is recommended for estimating small cold cleaning emissions.[18] A major advantage of this approach is that contacts to many indifferent and frequently small facilities are avoided, as is the processing and storage of a great amount of data. A potential disadvantage of a per capita approach is that the correlation between degreasing emissions and population is not known. However, assuming that a correlation exists is probably reasonable in making estimates for broad urban areas.

The use of a per capita factor for estimating VOC emissions from small cold cleaning operations should be qualified. First, the use of this factor will include all cold cleaning emissions in the area of application. Hence, to yield area source emissions, any cold cleaning solvent use identified in the point source inventory should be subtracted from the total. To this end, cold cleaning degreasing should be distinguished from open top and conveyorized degreasing in the point source inventory, as is discussed previously in this section.

Second, the 3 lb/capita/year factor represents only reactive VOC. A factor of 4 lb/capita/year would include all VOC of which approximately 25 percent is 1,1,1-trichloroethane, methylene chloride, and trichlorotrifluoroethane.[20]

Third, the assumption is that most of the solvent contained in the waste evaporates inside the inventory area and is not encapsulated or incinerated. If the agency is aware of different disposal practices within its jurisdiction or is planning any control measures that would alter these practices, this factor should be changed to reflect these different practices. One estimate indicates that half of the emissions occur during disposal of the waste solvent.[20] Therefore, only this fraction of the factor should be adjusted. For example, if 400 tons of solvent waste are disposed of outside the inventory area, and 200 tons of solvent waste are brought <u>into</u> the inventory area, then the <u>net</u> disposal outside the inventory area is only 200 tons. If the 200 tons represent 25 percent of the waste solvent, which means that 75 percent remains in the inventory area, then the factor would be adjusted accordingly ($1.5 + 1.5 \times 0.75 = 2.6$).

An alternative to inventorying cold cleaner emissions by per capita factors is the use of cold cleaning emissions-per-employee factors. While this method may be theoretically more accurate than using per capita factors because of the large number of SIC codes associated with cold cleaning operations, many such emissions-per-employee factors would be needed to scale up the inventory to encompass all cold cleaning emissions. Moreover, emissions-per-employee factors that can be applied to cover only cold cleaning operations have not yet been defined. Thus, while being theoretically more accurate, the emissions-per-employee approach will require more effort and documentation than will the per capita factor method.

4.3.3 SURFACE COATING

Surface coating operations can be separated into two groups, industrial and nonindustrial. Industrial surface coating operations for such products as appliances, automobiles, paper, fabric, and cans are usually major sources of volatile organic compounds and should be listed as point sources, although small sources do exist. Nonindustrial surface coating includes refinishing of automobiles and architectural coatings which are customarily inventoried as area sources.

Section 4.3.3 discusses various techniques available for inventorying surface coating area sources. Emphasis is placed on the nonindustrial applications of surface coating, specifically automobile refinishing and architectural surface coating. Be aware that other small industrial surface coating operations may exist which emit less than the agency's point source cutoff level. Small metal finishing shops are an example of this. Since no reliable techniques are available for handling small industrial surface coating operations as area sources, the agency should try to identify as many as possible in the point inventory.

4.3.3.1 Architectural Surface Coating

Architectural surface coatings, often called "trade paints," are used primarily by homeowners and painting contractors to coat the interior/exterior of houses and buildings and on the surfaces of other structures such as pavements, curbs, or signs. Coating materials are applied to surfaces by spray, brush, or roller, and dry at ambient conditions. Architectural coatings differ from industrial coatings, which are applied to manufactured products and are usually oven cured. Painting contractors and homeowners are the major users of architectural coatings.[15,22]

Emissions result when the solvent which carries the coating material evaporates and leaves the coating material on the applied surface. Solvents used for thinning architectural surface coatings and for clean up after application also contribute significantly to VOC emissions associated with the architectural coating process. Waterborne coatings generally contain much less solvent than do solventborne coatings. Additional information on architectural surface coating can be found in References 15 and 22.

The most accurate method of inventorying VOC emissions from the application of architectural surface coatings is to obtain sales and distribution data from local wholesale and retail suppliers of solventborne paints, varnishes, and other coatings. Direct contacts may be made to all distributors or, alternatively, brief survey forms may be mailed if a large number of contacts are necessary. Information should be elicited during such contacts on the quantity of both solventborne and waterborne coatings sold and on the average solvent content of each type of coating. Moreover, information on the use of associated solvents for thinning and cleaning must also be collected. By assuming typical densities of 6.5 and 8.6 pounds per gallon, respectively, of solventborne and waterborne coatings, and applying the average

solvent contents determined in the survey for each solvent type, emissions can be readily computed. Thinning solvent emissions can be similarly calculated by assuming a density of 7.0 pounds per gallon. One study suggests average solvent contents for solventborne and waterborne coatings are 54 and 8 percent by volume, respectively.[23] However, because the ranges of solvent contents in these two types of coatings can vary so greatly, local data should be used if available. A basic assumption in such calculations is that all the solvent in the coating evaporates upon application.

An advantage of using local sales data to estimate architectural surface coating emissions is that local consumption practices are taken into account, which should enhance inventory accuracy. A disadvantage is that much more work is required to develop emission estimates in this manner than is required using the per capita factor, which is discussed in the subsequent paragraph. Another disadvantage is that distributors may not be willing to divulge sales information and may not know where their product is finally used. In this last regard, sales data must necessarily be adjusted to account for coatings distributed into and out of the inventory area.

If local data cannot be obtained on architectural surface coating, a national average factor of 4.6 lb/capita/year is recommended for estimating architectural surface coating solvent evaporation. This factor is derived in Reference 18 from national consumption data. Thinning and cleanup solvent use, which accounts for 25 to 40 percent of all solvent loss associated with architectural surface coating, is included in this per capita factor.

None of the solvents used in architectural surface coatings or thinning and cleanup contains any of the nonreactive compounds discussed in Chapters 2 and 5. A breakdown of architectural surface coating emissions by constituent compounds is available in Reference 22.

4.3.3.2 Automobile Refinishing

Automobile refinishing is the repainting of worn or damaged automobiles, light trucks, and other vehicles. Surface coating during manufacture is not considered refinishing. In automobile refinishing, lacquers and enamels are usually spray applied in paint booths. Since vehicles contain heat sensitive plastics and rubber, the solventborne coatings used are those which can dry in low temperature ovens. Paint booths may be equipped with paint arrestors or water curtains to handle overspray. Additional process, emissions, and control information may be obtained from References 24 and 25.

One approach to inventorying auto body shops is to contact each one, or a representative sample, and to obtain information on the quantity of paint and solvent used in these operations. Such an approach is generally not recommended except for larger facilities, because of the large number of small shops in most areas and because of the unlikelihood that the shop owners or managers would be able to provide the consumption or average solvent information needed by an air pollution control agency.

Another approach is to use an emissions-per-employee factor and to apply it to the number of employees in SICs 7531 and 7535. Based on nationwide estimates of solvent loss from automobile refinishing and employment in these two SICs, an average factor of 2.6 tons/employee/year may be applied as an estimate of auto body shop emissions in the area.[26] Employment by SICs is available at county levels in Reference 21.

An agency might conduct a survey of auto painting businesses as another approach to estimating emissions from automobile refinishing. The following information could be requested: the number of cars painted on a typical summer day or during the summer quarter; the percentage of total coat paint jobs (as opposed to partial coat); the amounts of paint, lacquer, enamel, and primer that were used; and the amount of thinning solvents used. Information from this type of survey can then be used to determine the emission factors for total and partial paint jobs. A factor of pounds VOC per total paint job and a factor of pounds of VOC per partial paint job would then applied to the number of shops and number of jobs of each kind per shop to estimate annual VOC emissions.

Solvents used in auto body refinishing will consist entirely of reactive VOC. Thus, all solvent usage associated with auto body refinishing should be included in the inventory used in the agency ozone control program.

4.3.3.3 Other Small Industrial Surface Coating

Industrial surface coating includes the coating, during manufacture, of magnet wire, automobiles, cans, metal coils, paper, fabric, metal and wood furniture, and miscellaneous products (see Table 2.2-1). Materials applied in coating include adhesives, lacquers, varnishes, paints, and other solventborne coating material. Many surface coating facilities generate sufficient emissions to be considered major sources. However, small sources most probably will still be present in any developed inventory area.

To the maximum extent possible, small industrial surface coating operations should be treated as point sources. Only if the agency is aware of numerous facilities emitting less than its point source cutoff level, but does not have the resources to contact these small facilities, should the point source totals be scaled up to account for the missing emissions. Scaling up is discussed in Chapter 6.

Scaling up is usually based on employment totals within various industrial sectors. The agency will need to develop emissions-per-employee factors from data in its point source inventory on various surface coating operations. The point source totals are scaled up by applying these factors to estimates of total employment within appropriate SICs. Data on total employment by industrial sector should be obtained from local planning agencies. If local employment data are unavailable, Reference 21 presents employment by SIC at the county level.

If scaling up is attempted to cover missing small industrial surface coating operations, care should be taken because these operations are carried

out in a wide variety of applications covered by numerous SICs. Moreover, some small operations may be found in facilities whose principal business is not typically associated with surface coating, business such as the manufacturing of transformers, computers, or even crockpots. Particular attention should be paid to the miscellaneous metal parts and products surface coating operations discussed in Reference 27. A thorough effort is needed to locate all of the sectors where surface coating is done, and to develop reliable factors for scaling up the inventory totals. An example for scaling up emissions is presented in Chapter 6.

4.3.4 GRAPHIC ARTS

The graphic arts or printing industry consists of approximately 40,000 facilities. About half of these establishments are in-house printing services in nonprinting industries. Printing of newspapers, books, magazines, fabrics, wall coverings, and other materials is considered a graphic arts application. Five types of printing are used in the industry: letterpress, flexography, lithography, (roto) gravure, and screen process printing. Detailed descriptions of the different types of printing operations are given in References 16 and 28.

An emission factor of 0.8 lb/capita/year is recommended for estimating VOC emissions from small graphic arts facilities which emit less than 100 tons per year. Graphic arts facilities which emit more than 100 tons of VOC per year are excluded from this factor and should be inventoried by point source procedures in Chapter 3. Any emissions associated with less than 100 tons per year sources identified in the point source inventory should be subtracted from the per capita derived emissions total.[18] The following example demonstrates the use of the factor.

<u>Example</u>: An urban area with an inventory base year population of 808,500 people has been inventoried with a point source cutoff of 25 tons per year per plant. Plant visits and stack tests at a major publication plant equipped with rotogravure presses have determined controlled emissions of 110 tons per year at the facility. A questionnaire survey has identified four additional plants with uncontrolled VOC emissions of 18, 22, 45, and 65 tons per year, respectively.

<u>Calculations</u>: Per capita derived emissions = 808,500 x 0.8 lb VOC/capita/yr

= 649,000 lb VOC/yr

= 320 tons VOC/yr

Area source emissions = 320 tons - (18 + 22 + 45 + 65) tons

= 320 - 150 = 170 tons VOC/yr

Point source emissions = 150 + 110 = 260 tons VOC/yr

Total graphic arts emissions = 260 + 170

= 430 tons VOC/yr

Note that the major point source is not subtracted from the per capita derived emissions. Generally, major plants engaged in publication and package printing are very large emitters and thus would be included in the point source inventory.

The agency may elect to handle many of the smaller printing establishments in its inventory as point sources. A questionnaire covering graphic arts facilities is shown in Appendix D. However, because so many thousands of small printing establishments exist in the U.S., and because each unit emits, on average, less than ten tons per year of VOC, the agency may need considerable resources to handle all of these establishments in the point source data base. Moreover, care will have to be taken in (1) locating all of these small operations, because so many are found in nonprinting industries and (2) accounting for additional solvents used for thinning and cleanup. An emissions-per-employee approach is not recommended for the graphics arts industry because so many SIC codes other than 27 (printing and publishing) would have to be covered in the scaling up process.

All of the solvents used in the graphic arts industry are considered reactive and should be included in the VOC inventory developed for use in the agency's ozone control strategy.

4.3.5 CUTBACK ASPHALT PAVING

Cutback asphalt is a type of liquified road surface that is prepared by blending or "cutting back" asphalt cement with various kinds of petroleum distillates. Cutback asphalt is used as pavement sealant, tack coat, and as a bonding agent between layers of paving material. VOCs are emitted to the atmosphere as the cutback asphalt cures and as the petroleum distillate, used as the diluent, evaporates. The diluent content of cutbacks ranges from 25 to 45 percent by volume, averaging 35 percent. Gasoline or naphtha is used as the diluent in "rapid cure" cutback (RC), kerosene is used in "medium cure" cutback (MC), and low volatility fuel oil type solvents in "slow cure" road oils (SC).[29]

VOC emissions from cutback asphalts result from the evaporation of the petroleum distillate solvent, or diluent, used to liquify the asphalt cement. Emissions occur at both the job site and the mixing plant. At the job site, VOCs are emitted from the equipment used to apply the asphaltic product and from the road surface. At the mixing plant, VOCs are released during mixing and stockpiling. The largest source of emissions, however, is the road surface itself. Additional information on cutback asphalts is found in Reference 29.

For any given amount of cutback asphalt, total emissions are assumed to be the same, regardless of stockpiling, mixing, and application times. The two major variables affecting both the quantity of VOC emitted and the time over which emissions occur are (1) the type and (2) the quantity of petroleum

distillate used as diluent. As an approximation, long term emissions from cutback asphalts can be estimated by assuming that 95 percent of the diluent evaporates from rapid cure cutback asphalts, 70 percent from medium cure cutbacks, and about 25 percent from slow cure cutbacks, by weight percent. These percentages are applicable in estimating emissions occurring during the ozone season. Some of the diluent appears to be retained permanently in the road surface after application.[10,29]

Because the use of cutback asphalts varies so much from area to area, local records should be accessed to determine usage in the area of concern. Ideally, data should be obtained from the state or local highway department or from highway contractors on the quantity of each type of cutback applied, as well as the diluent content of each. If local information is not available, the Asphalt Institute in College Park, Maryland, prepares annual reports of the total cutback asphalt usage by state.[30] These state totals can be allocated to specific counties relative to the percentage of the state employment for SIC category 1611 located in each county. Employment data can be obtained from the Bureau of Census County Business Patterns.[21] From these data, the equations or tables in Section 4.5 of AP-42 can be used to compute long term solvent evaporation. If the diluent content is not known by the local highway department personnel, default values of 25, 35, and 45 percent can be assumed for slow cure, medium cure, and rapid cure cutbacks, respectively.

All of the VOC from the petroleum-based diluents used in cutbacks is considered photochemically reactive. Thus, all evaporative emissions associated with cutback asphalt use should be included in any VOC control strategy inventory.

4.3.6 ASPHALT ROOFING KETTLES AND TANKERS

One approach to estimating emissions in this category involves sending survey forms to asphalt roofing operators requesting the amounts of asphalt used and fuel burned. It is assumed that only particulate emissions occurred during application of the asphalt. VOC emissions would occur from fuel combustion during the operation of the asphalt roofing kettles and containers. AP-42 emission factors can be used for fuel combustion (Table 1.4-1 for natural gas; Table 1.5-1 for propane and butane; Table 3.3-1 for diesel and gasoline).

To compute the VOC emissions from asphalt roofing operations, the total amount of fuel used in each of the five fuel categories should be multiplied by the AP-42 emission factor for the fuel and converted into tons.

4.3.7 PESTICIDE APPLICATION

Pesticides broadly include any substances used to kill or retard the growth of insects, rodents, fungi, weeds, or microorganisms. Pesticides fall into three basic categories: synthetics, nonsynthetics (petroleum products), and inorganics. Formulations are commonly made by combining synthetic materials with various petroleum products. The synthetic pest killing compounds in such formulations are labeled as "active" ingredients, and the petroleum product solvents acting as carriers or diluents for the active

ingredients are labeled "inert." Neither of these toxicologic designations, active or inert, should be interpreted as indicators of photochemical reactivity; these designations refer only to their toxicological action. For the purposes of a VOC emissions inventory, both the active and the inert ingredients of the pesticides should be inventoried.

It has been noted that the "inert" portion of the pesticide is not required to be listed on the pesticide label. One approach to estimating the solvent (inert) carriers uses figures of pounds of solvents used in pesticide formulations and pounds of synthetic organic pesticides used (from the 1977 Census of Manufacturers - Agricultural Chemicals). The active ingredient can then be multiplied by 1.45 to get the solvent (inert) carrier, or by 2.45 to get total usage. This approach assumes that the amount of solvent used is proportional to the amount of organic pesticide used.

Petroleum products are often applied directly to control insects on trees (dormant and summer oils), weeds (weed oils), and fungus on produce (light mineral oils). Inorganic pesticides are not of interest in the inventory, since they contain no organic fraction.[15,31]

Pesticide use is typically associated with agricultural applications. However, a significant enough quantity may be used in some urban and suburban areas to warrant including pesticide emissions in the urban VOC inventory. As examples of use, municipalities may engage in various spraying programs to control mosquitoes, tree-damaging insects, or weed growth in shallow lakes or tidal marshes. Pesticides are also used in homes and gardens.

Local, state, and Federal departments of agriculture should be contacted to determine the quantities and types of pesticides applied in the inventory area. The quantity of inorganics, which are mostly sulfur compounds, should first be eliminated from the above total. Then, as a crude estimate, the remaining synthetic and nonsynthetic total should be multiplied by a factor of 0.9 to estimate the amount that evaporates and can be considered photochemically reactive VOC.[32] A much more detailed procedure which may be applied to estimate emissions for agricultural applications is described in Reference 31. This procedure is much more data-intensive and is recommended only in areas where agricultural pesticides applications are a major source of VOC.

Several studies have shown that pesticide application in agricultural areas may range from about 2 to 5 lb/yr/harvested acre.[13,31] This use includes both synthetic and nonsynthetic pesticides. These factors should be applied as a check on the figures determined from local sources.

Municipal pesticide use in urban areas should be determined by contacting appropriate state or local agencies, including local public health departments, parks departments, highway departments, or private concerns such as utilities, exterminators, and landscapers. These groups will know the extent of pesticide application for insect control and weed killing, in addition to that used in agricultural applications. The same types of data should be obtained and the

same procedures followed for estimating evaporative VOC as are suggested for agricultural pesticides.

A nominal quantity of pesticides is additionally employed in homes and gardens. This small amount is reported to be less than 0.25 lb/capita/year on average[31] and is covered in the next section as part of commercial/consumer solvent use.[19]

All of the VOC accounted for by the above procedures is considered photochemically reactive. If a seasonally adjusted inventory is compiled, information on the seasonal application of each pesticide will have to be collected. Contrary to expectation, not all pesticides are applied during the ozone season. For example, dormant season oils are applied during the cold months of the year.

4.3.8 COMMERCIAL/CONSUMER SOLVENT USE

Certain commercial/consumer uses of products containing volatile organics cannot easily be identified by questionnaires, surveys, or other inventory procedures yielding locale-specific emission estimates. Thus, a factor of 6.8 lb/capita/year is recommended for estimating emissions from this category. This factor includes the following commercial/consumer subcategories:

	Reactive VOC
Household products	2.0 lb/capita/year
Toiletries	1.4 lb/capita/year
Aerosol products	0.8 lb/capita/year
Rubbing compounds	0.6 lb/capita/year
Windshield washing fluids	0.6 lb/capita/year
Polishes and waxes	0.3 lb/capita/year
Nonindustrial adhesives	0.3 lb/capita/year
Space deodorants	0.2 lb/capita/year
Moth control	0.1 lb/capita/year
Laundry detergents and treatment	<0.1 lb/capita/year
TOTAL	6.3 lb/capita/year

The above factors are based on national estimates of solvent use in each of these end use sectors. Because of the difficulty involved in developing local consumption estimates for the myriad products comprising these categories, the agency should generally not try to do so.[18,19]

EPA is currently revising these factors based on updated national estimates of solvent use.[33] The number of commercial/consumer subcategories being considered will also be expanded to provide a more thorough coverage of the category. The revised factors are currently undergoing internal review and will be made available following this process.

It should not be inferred that the commercial/consumer factor is a catchall estimate to account for deficiencies in point source or area source inventories. Specifically, the factor does not include: small cold cleaning degreasing operations; dry cleaning plants; auto refinishing shops; architectural surface coating applications; graphic arts plants; cutback asphalt paving applications; and agricultural and municipal pesticide applications. These categories must be inventoried by point or area source procedures and be tabulated separately.

The major organic materials comprising this 6.3 lb/capita/year factor are special naphthas, alcohols, carbonyls, and various other organics. Nonreactive halogenates used in aerosols and other products are excluded from this factor. Thus, this factor differs from what is found in AP-42. This value should be used in a VOC control program inventory. Speciation data for use in other applications are available in References 18 and 19.

4.4 WASTE MANAGEMENT PRACTICES

The EPA Office of Air Quality Planning and Standards (OAQPS) is currently engaged in activities studying the characteristics and impacts of air emissions from waste management practices.[34] Included in these efforts are the development of estimation methodologies for VOC emissions from municipal landfills and from hazardous waste treatment, storage, and disposal facilities (TSDFs) such as land treatment, landfills, surface impoundments, and wastewater treatment operations. In addition, the Office of Water Regulations and Standards has conducted studies to evaluate the fate of priority pollutants and the impacts from the discharge of hazardous wastes on the operations of publicly owned treatment works (POTWs), as regulated under the Domestic Sewage Exclusion of the Resource Conservation and Recovery Act.[35] Based upon the information provided by these studies, methodologies for the estimation of county level VOC emissions from POTWs, TSDFs, and municipal landfills have been developed and are detailed in the following sections.

4.4.1 PUBLICLY OWNED TREATMENT WORKS (POTWs)

Recent research activities with respect to VOC emissions from POTWs have produced emission estimates which support the contention that 85 percent of all volatile pollutants discharged to unacclimated wastewater treatment systems are stripped to the ambient air.[36-39] Based upon these findings and the annual VOC loadings reported for raw POTW influent, a national VOC emissions level of 78,540 megagrams is predicted for POTWs annually.[34]

Additionally the concentration of volatile organic compounds found in POTW influent has been shown to be directly proportional to the industrial contribution to a POTW.[35] This implies that national VOC emission estimates for unacclimated treatment systems can be allocated to the county level based upon the total industrial flow per county.

The total industrial flow discharged to POTWs in 1984 has been reported as 1.6×10^{12} gallons.[40] If it is assumed that the industrial wastewater contribution represents the bulk of the volatile organic constituents of the

influent wastestream, an emission factor can be derived by dividing the total estimated VOC emissions by the total industrial flow. The results of this calculation provide an emission factor of 1.1×10^{-4} lbs VOC emitted/gallon industrial wastewater discharged to a POTW. This factor is recommended for estimating VOC emissions from POTWs where measured emissions data are not available. The annual industrial wastewater contribution for an individual POTW can range from 0 to 100 percent. If the actual annual industrial wastewater contribution to the POTWs of a county is unknown, then 16 percent of the total annual flow (which represents the average industrial discharge percentage for POTWs nationally) can be used to approximate the industrial wastewater discharge.[40]

4.4.2 INDUSTRIAL WASTE WATER TREATMENT AND HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES (TSDFs)

Methodologies for estimating emissions of VOCs from TSDF operations are currently under development in the Emission Standards Division (ESD) of OAQPS. As part of this effort, models for estimating emissions from TSDF operations have been compiled and are discussed in Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF) - Air Emission Models.[41] These models can be used to estimate emissions from hazardous waste surface impoundments and open tanks, land treatment, landfills, and wastepiles as well as from hazardous waste transfer, storage, and handling and industrial waste water treatment operations. The use of these models is illustrated below in an example emission calculation for a surface impoundment.

4.4.2.1 Example Calculation

An example facility operates a storage impoundment which receives primarily benzene in water at a concentration of 1,000 g/m^3. The following input parameters are used:

area	1,500 m^2
depth	1.8 m
volume	2.700 m^3
retention time	20 days
flow	0.0016 m^3/s
temperature	25°C
windspeed	4.47 m/s
constituent	benzene in water
concentration	1,000 g/m^3
Henry's law constant	5.5×10^{-3} $atm \cdot m^3/g$ mol
diffusivity in air (benzene)	0.088 cm^2/s
diffusivity in water (benzene)	9.8×10^{-6} cm^2/s
viscosity of air	1.81×10^{-4} $g/cm \cdot s$
density of air	1.2×10^{-3} g/cm^3

The basic relationship describing the mass transfer of a VOC from the liquid in a quiescent impoundment to the air can be expressed as:

$$E = KA\ (C_L - C_G)$$

where E = emission rate (g/s)
K = volatilization rate constant (m/s)
A = liquid surface area (m^2)
C_L = concentration of VOC in liquid phase (g/m3)
C_G = concentration of VOC in gas phase (g/m^3)

Since C_G is assumed negligible compared to C_L, the equation simplifies to:

$$E = KAC_L$$

The volatilization rate constant (K) is estimated from a two-phase resistant model that is based upon the liquid-phase mass transfer coefficient (k_L), the gas-phase mass transfer coefficient (k_G), and Henry's law constant in the form of a partition coefficient (K_{eq}). The liquid-phase mass transfer coefficient (k_L) is calculated for a given U_{10} and F/D using the following equation:[42,43]

$$k_L = [2.605 \times 10^{-9}\ (F/D) + 1.277 \times 10^{-7}]\ U_{10}^2\ (D_w/8.5 \times 10^{-6})^{.67}\ m/s$$

where: U_{10} = windspeed = 4.47 m/s
F/D = fetch/depth = 24.3

$$k_L = 4.2 \times 10^{-6}\ m/s$$

The gas-phase mass transfer coefficient (k_L) is calculated using:

$$k_G = 4.82 \times 10^{-3}\ U^{0.78}\ Sc_G^{\ -.67}\ d_e^{\ -.11}\ (m/s)$$

where: Sc_G = Schmidt No. for gas = 1.71
d_e = effective diameter = 43.7 m

$$k_G = 7.1 \times 10^{-3}\ m/s$$

The partition coefficient (K_{eq}) is calculated as:

$$K_{eq} = H/RT = .225$$

Volatilization rate constant (K) can now be calculated using:

$$\frac{1}{K} = \frac{1}{k_L} + \frac{1}{k_G\ K_{eq}}$$

$$K = 4.2 \times 10^{-6}\ m/s$$

To calculate the concentration in the liquid phase (C_L), the following is used:

$$QC_o = KC_LH + QC_L$$

$$C_L = QC_o/(KA + Q)$$

where: Q = flow rate = 0.0016 m^3/s
C_o = influent concentration = 1,000 g/m^3

$$C_L = 198\ g/m^3$$

To estimate emissions (E), the equation presented above is used:

$$E = KAC_L = 1.25\ g/s = 39\ \text{megagrams/year} = 43\ \text{tons/year}$$

Thus, benzene emissions from the surface impoundment are estimated to be 39 megagrams per year. Algorithms and example calculations for other TSDF operations are located in Reference 41.

4.4.3 MUNICIPAL SOLID WASTE LANDFILLS

A municipal solid waste landfill is regulated under Subtitle D of the Resource Conservation and Recovery Act (RCRA) and receives primarily household and/or commercial waste. In the United States, approximately 209 million megagrams of waste are received each year by an estimated 6,033 active municipal solid waste landfills. About 54 percent of the 209 million megagrams of waste is household waste and 28 percent is commercial waste.[44]

VOC emissions are produced from municipal solid waste landfills by three mechanisms: volatilization, chemical reaction, and biological decomposition of liquid and solid compounds into other chemical species. Factors affecting volatilization include: partial pressure of the constituent; constituent concentration at the liquid-air interface; temperature; and confining pressure. Chemical reactions are also affected by temperature, as well as: waste composition; moisture content; and the practice of separate disposal areas for different waste types. Factors affecting biological decomposition are: nutrient and oxygen availability; refuse composition; age of the landfill; moisture content; temperature; pH; and waste that is toxic to bacteria.

An estimate of VOC emissions from landfills is more accurate if field test data and gas generation rate models are used. Procedures for estimating landfill air emissions are being developed by EPA in setting air standards for municipal solid waste landfills. Until these procedures are available and if field test data or if collection of the data is not feasible, average emission factors may be used to estimate VOC emissions from municipal solid waste landfills. However, the estimate of emissions will be a crude approximation because of the many factors affecting landfill air emissions which are not considered (e.g., age of landfilled waste, pH, refuse type, and composition). An emission factor of 13.6 tons of VOC per year per million tons of refuse was derived from field data collected by the South Coast Air Quality Management District. Emissions of VOC were correlated to the amount of landfilled waste using data from eleven landfills where the moisture content of the refuse was

less than 30 percent.[44] This emission factor represents an estimate of the average annual emissions over the lifetime of a landfill and does not account for changes in emissions over time.

Because the moisture content of a landfill has been found to affect the rate of landfill gas generation, an additional emission factor was developed for landfills where the moisture content of the landfill is average or above average. The moisture content of a landfill is a function of the annual precipitation in the area concerned as well as the type of refuse. This additional factor of 2.6 was developed to take into account the effect of average or above average moisture content using data from 20 landfills.[44] To predict emissions from a landfill located in a state with average or above average precipitation, the additional factor of 2.6 is used in conjunction with the 13.6 tons VOC per year per million tons of refuse. These states are defined as the states with annual precipitation greater than 23 inches and include all except the following twelve: Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, North Dakota, South Dakota, Utah, and Wyoming. These emission factors should be used only in cases where a gross approximation of emissions is needed. For a discussion of models and field test procedures that can be used to generate a more reliable estimate of VOC emissions from municipal solid waste landfills, see Reference 44.

4.4.4 SOLID WASTE INCINERATION

Solid waste may consist of any discarded solid materials from industrial, commercial, or residential sources. The materials may be combustible or noncombustible and are often burned to reduce bulk, unless direct burial is either available or practical.

In some local areas, solid waste disposal by burning can be a significant source of organic emissions. The area source solid waste VOC emissions category includes on-site refuse disposal by residential, industrial, and commercial/institutional sources. On-site incineration is the confined burning of waste leaves, landscape refuse, or other refuse or rubbish. Slash and large scale agricultural open burning are not included in this VOC emission category. Large open burning dumps and municipal incinerators are usually classed as point sources, but many smaller incinerators may be so classified, depending on the needs of the agency. For emission inventory purposes, only solid waste actually burned is of interest. Unfortunately, very little quantitative information about on-site solid waste disposal is available.

Some locales have conducted comprehensive surveys of solid waste disposal practices. Where such a survey is available, it should be used to estimate solid waste quantities. Many such surveys cover only collected waste, however, and are of limited value for determining on-site waste disposal quantities.

If solid waste survey data are not available, quantities are usually estimated by per capita generation factors. Nationwide, it is estimated that about 10 pounds of solid waste are generated per capita per day.[45] By proportioning the various disposal methods, waste generation can be estimated

for on-site incineration and open burning. In addition, data useful for estimating area source solid waste quantities are available in several surveys of nationwide solid waste disposal practices.[46-48] It should be noted that data on nationwide or regional solid waste generation may yield extremely inaccurate predictions for local areas. The tremendous variation in solid waste disposal practices from one community to another renders such nationwide averages rough estimates at best. Furthermore, local regulations governing solid waste disposal should be taken into account. In some areas and under certain conditions, on-site incineration is regulated or may be prohibited. If so, the corresponding generation factor(s) should not be applied. Under such circumstances, assume that the solid waste normally allotted to on-site disposal is handled by some method not involving burning, such as landfilling or resource recovery.

4.4.4.1 On-Site Incineration

The waste generation factors given in Table 4.4-1 may be used with appropriate emission factors for VOC, NO_x, and CO in AP-42 to estimate on-site solid waste incineration by residential, commercial/institutional, and industrial sources. Care should be taken in the application of these waste generation factors. If a number of on-site incinerators have been identified as point sources, it may be appropriate to reduce or eliminate the area source estimates. In addition, these factors are 1975 data and should be updated to the inventory base year with procedures which can be obtained from NEDS contacts in EPA Regional offices. If data are available from registration or permit files for solid waste disposal equipment, these data may provide a more accurate estimation of on-site incineration quantities than the factors given here. Reference 48 presents additional data on incinerators, such as size of units or controls, that may be useful in making more detailed estimates for on-site incineration.

4.4.4.2 Open Burning

Little national data are available to estimate open burning activities. However, since many areas require open burning permits, open burning can be best estimated by contacting the most knowledgeable local official and by taking into account the effects of any local open burning restrictions or prohibition. If no local estimates can be made, the waste generation factors in Table 4.4-2 may be used to estimate the quantity of solid waste to be multiplied by the appropriate VOC, NO_x, or CO emission factor from AP-42. Note that the factors for residential and commercial/institutional open burning are applied to rural populations. Also, these factors should be updated to inventory base year levels using procedures available from NEDS contacts in EPA Regional Offices.

4.5 SMALL STATIONARY SOURCE FOSSIL FUEL USE

This source category includes small boilers, furnaces, heaters, and other heating units too small to be considered point sources. Note that both point and area source combustion equipment produce only small amounts of organics relative to most other sources. Thus, the agency many not consider it

TABLE 4.4-1. FACTORS TO ESTIMATE TONS OF SOLID WASTE BURNED IN ON-SITE INCINERATION[a]

EPA Region	Residential (Tons/1000 (population/yr)	Commercial/Institutional (Tons/1000 population/ yr)	Industrial (Tons/1000 mfg employees/yr)
I	52	64	125
II	11	65	180
III	4	54	560
IV	4	23	395
V	61	87	420
VI	23	33	345
VII	75	37	325
VIII	87	49	430
IX	90	5	80
X	90	29	170
National average	41	50	335

[a]References 21, 46, 47, 50.

TABLE 4.4-2. FACTORS TO ESTIMATE TONS OF SOLID WASTE DISPOSAL THROUGH OPEN BURNING[a]

	Residential (Tons/1000 (population/yr)	Commercial/Institutional (Tons/1000 population/ yr)	Industrial (Tons/1000 mfg employees/yr)
National average	450[b]	24[b]	160

[a]References 21, 46, 47, 49, 50.

[b]For rural population only. Open burning assumed banned in urban areas.

worthwhile to perform the detailed procedures given below if its primary concern is updating the VOC inventory and if an existing inventory already includes combustion. The procedures below may be followed if a detailed VOC inventory is needed or if other pollutants, for example NO_x or CO, from small stationary source fuel combustion are of concern. Because VOC emissions from this source are estimated by simply multiplying the typical quantity of fuel used by an appropriate emission factor, the techniques below are designed to yield fuel use data for various types of combustion equipment. Also, the same methodologies can be used to estimate NO_x and CO emissions.

Area source stationary source fuel use may be divided into three categories: residential, commercial/institutional, and industrial. Residential dwellings are all structures containing fewer than twenty living units, so that large apartment houses are excluded. Commercial/institutional facilities are establishments engaging in retail and wholesale trade, schools, hospitals, government buildings, and apartment complexes with more than twenty units per structure. The commercial/institutional category covers all establishments defined by SIC groups 50-99. Industrial fuel combustion includes all manufacturing establishments not classified as point sources. These establishments are defined by SIC groups 20-39.[57] Collectively, the three categories account for all the stationary fuel combustion activities not usually reported as point sources.

The area source fuel use total is determined by subtracting all fuel used by point sources from the areawide total of fuel use. Hence, before a specific methodology can be applied to calculate area source fuel use, the total fuel consumed in an area must be determined. Such data are usually obtained from fuel dealers and distributors, published references, or government regulatory agencies. Some fuel retailers maintain sales records that can be a valuable source of information for determining total fuel consumption. The information needed from fuel dealers concerns their annual sales to each source category (preferably by county). The area source totals of residential and commercial/institutional fuel consumption are then simply the fuel dealers' figures minus any fuel consumed by the fuel dealers. The accuracy of survey results will be significantly reduced if some fuel dealers are overlooked. It may be that not all fuel dealers will be able to furnish adequate information. Generally, natural gas dealers can best furnish the required data. Other dealers either are reluctant to release information, or simply do not have the detailed breakdowns required.

Unfortunately, the above techniques cannot assure that fuel dealer sales accurately represent fuel consumption. Sales of coal to industrial sources or of wood to residential sources, for instance, may represent only a part of the total fuel consumed, since much of the fuel consumed in some areas may not come from retail dealers. Other methods should be used for those cases in which fuel dealers cannot provide adequate data on total fuel sales. It should be emphasized, however, that information provided by dealers, although perhaps incomplete, can provide insights into fuel use patterns that would not be discovered by other methods. An example questionnaire for obtaining fuel use data from fuel suppliers is included in Reference 52.

Published references are the most common sources of fuel use data. Reports produced by the U.S. Department of Energy contain data on fuel sales and distribution. The advantages of using this information are that data for all parts of the nation are readily available and are updated every year. The drawback to the use of this material is that fuel data are reported by state only. They are not broken down into the desired source categories, and county totals must be estimated by apportioning state totals. This geographical apportioning step, which may also be necessary for data obtained from fuel dealers, can become quite complicated and can involve a large number of calculations.

Finally, useful data may sometimes be obtained from federal and state regulatory agencies. The Federal Power Commission compiles data on fuel used by electric utilities and on natural gas company sales and pipeline distribution.[53,54] State utility commissions may be able to provide similar data. In addition, state revenue or tax departments may have data that would be helpful for determining fuel usage.

4.5.1 FUEL OIL CONSUMPTION

Data collection for fuel oil consumption covers the use of both distillate and residual oil. Distillate oil includes fuel oil grades 1, 2, and 4. Diesel fuel and kerosene also can be considered distillate oils. Nationwide, residential and commercial/institutional sources are the largest consumers of distillate oil. Residual oil includes fuel oil grades 5 and 6. In most areas, residual oil is not used by residential sources, but significant amounts may be consumed by industrial and commercial/institutional users.

Literature data must be generally relied upon to determine total fuel oil consumption. Local fuel dealers and government agencies usually have been unable to supply adequate data on fuel use. The data published by the Department of Energy in Petroleum Supply Monthly are the most acceptable.[55] For selected years, data are also available from the Census of Manufacturers, published by the Bureau of the Census.[56] This publication is not produced annually, however, so it is of limited use for most area source inventory purposes.

A procedure for determining area source fuel consumption can be found in Census of Manufacturers and other publications.[57] This procedure involves calculating state fuel oil consumption, subtracting point source consumption data, and allocating fuel oil use into county inventory area. A full discussion of this method is found in the AEROS Manual Series, Volume II.[2]

Due to the complexity of the method, it may be very cumbersome to apply on a large scale. Persons who wish to obtain the computer output for selected counties or further information may contact their EPA Regional Office or the National Air Data Branch, U.S. Environmental Protection Agency, MD-14, Research Triangle Park, NC 27711.

A simplified version of the method (discussed in AEROS) can be employed, but it sacrifices the accuracy of the results. Variations of the method may

include using different correlative relationships to predict fuel oil use. For instance, to predict distillate oil used for space heating, equations of the following types may be used:

$$\text{Oil consumed} = \frac{\#\text{ of oil burners} \times \text{avg size (BTU/hr)} \times 8760\text{ (hr/yr)} \times \text{load}}{140{,}000\text{ BTU/gallon}}$$

or,

$$\text{Oil consumed} = \frac{\#\text{ of oil burners} \times \text{heat loss (BTU/hr)} \times \text{heating degree days} \times \text{use factor}}{140{,}000\text{ BTU/gallon} \times \text{Design Range } (^{\circ}\text{F})}$$

where the heat loss is dependent on the average square feet of building space. The design range is the difference between inside temperature and the design outside temperature for an area.[57]

Use of these relationships requires collection of substantially more source data and determination of local load and use factors. Fuel oil trade association publications,[58] oil dealers, and utility companies may be able to provide some of this information. Modifications of the above equations may provide relationships for predicting residential, commercial/institutional, or industrial space heating fuel oil use, which can be summed to obtain grid, county, or state totals. The derived totals should be adjusted to conform with the state totals given in literature.[55] This step corrects for variations in the parameters used in the above equations.

4.5.2 COAL CONSUMPTION

A determination of both anthracite and bituminous coal consumption may be necessary. Anthracite, or hard coal, is found almost exclusively in Pennsylvania and is used in significant quantities only in states within easy shipping distance from Pennsylvania. Anthracite may be consumed by all source categories, although most is used by residential sources. Mining of bituminous, or soft coal, is more widespread than that of anthracite, so that bituminous coal is available in most areas of the country. Also considered as bituminous coal are lower grades of subbituminous coal and lignite. Bituminous coal is often favored for use by electric utilities, industries, and coke producers. Bituminous coal is used in some areas for residential and commercial/institutional heating.

The same general techniques used for fuel oil may be adapted to determine coal consumption. Residential coal use is calculated for each county with the following equation:

$$\text{Tons of coal per dwelling unit} = 0.003874\ e^{[7.6414 - (1000/\text{degree days})]}$$

The number of dwelling units using coal for space heating is obtained from Reference 59 and is updated annually with additional data from Department of Energy or Bureau of the Census data. Degree days are obtained from Reference 60. The coal use predicted by the above equation is distributed

between anthracite and bituminous coal based on the estimated residential market share of each.[61] Use of coal for other than space heating purposes is ignored. Methods used for calculation of commercial/institutional and industrial coal use are basically the same as those used for fuel oil. State totals are obtained from References 62 and 63.

4.5.3 NATURAL GAS AND LIQUIFIED PETROLEUM GAS CONSUMPTION

Few problems should be encountered in determining natural gas use by county. Natural gas companies are usually excellent sources of data. If gas companies are unable to supply adequate data, information from the Federal Power Commission,[34] state utilities commissions, and literature may be used. Liquified petroleum gas (LPG) use may also be considered in area source inventories. The LPG contribution to total emissions is not significant in most areas. Wherever LPG use is considerable, however, it may be reported as "equivalent natural gas" by assuming for emission calculations that each gallon of LPG is equivalent to 100 cubic feet of natural gas.

Residential natural gas use by county is computed using the following equation:[61]

Therms of Natural Gas Consumed =

$$47.5 \times A \times B^{0.367} \times \left(\frac{C}{D}\right)^{0.588} \times E^{0.125}$$

Where: A = total number of natural gas customers

B = annual heating degree days

C = number of dwelling units using natural gas for space heating

D = the larger of the number of dwelling units using natural gas for cooking or hot water heating

E = median number of rooms per dwelling unit.

Item A is obtained from American Gas Association reports, B from Local Climatological Data,[60] and C, D, and E from the Census of Housing.[63] For annual updates of each parameter, contact the NEDS representative in any EPA Regional Office.

The resulting natural gas use in therms (one therm = 100,000 BTU) is converted to cubic feet on the basis of natural gas heating value (usually 1000 to 1050 BTU/cubic feet). Residential LPG use is computed by county, using a simpler equation based only on number of dwelling units, heating degree days, and a regional use factor for LPG consumed in cooking and water heating.

Therms of LPG consumed = $(376 + 0.209\ B) \times H + (I \times J) + (K \times L)$

Where: B = annual heating degree days

H = number of occupied dwelling units using LPG for space heating

I = regional average consumption for water heaters, therms

J = number of occupied dwelling units using LPG for water heating

K = regional average consumption for cook stoves, therms

L = number of occupied dwelling units using LPG for cooking.

Regional average therms consumed by water heaters and cooking have been estimated by the American Gas Association and are summarized in Reference 61.

Commercial/institutional and industrial use of natural gas and LPG may be estimated by using the same methodology presented for fuel oil use and by obtaining state totals for fuel use from References 64 and 66. However, since natural gas utility companies usually have excellent records of sales, data preferably are obtained directly from the gas company. If records are not detailed enough to give county totals, some apportioning may be necessary. If fuel use totals for these categories can be obtained directly, use of the equations and procedures for commercial/institutional subcategories can be avoided. This step is particularly desirable for a detailed source inventory, since the equations in this section do not always yield accurate predictions of fuel use in a small area.

4.5.4 OTHER FUELS

Other fuels which may appear as area source fuels are wood, coke, and process gas. Census of Housing[59] data may be used to estimate residential consumption of wood, according to the following equation:[59,63]

$$\text{Residential wood use (tons/yr)} = 0.0017 \times \text{NHUHW} \times \text{HDG} \times \frac{\text{ARPH}}{5.0}$$

Where: NHUHW = number of housing units heating with wood
HDG = heating degree days
ARPH = average room per housing unit

Commercial/institutional and industrial wood use are usually ignored, unless surveys of potential sources indicate that wood is consumed by small sources in significant quantities. The most common users of wood as fuel are those wood processing plants that burn wood waste.

Users of coke and process gas can usually be identified only through questionnaire surveys. Neither of these fuels will be used by establishments which are classed as area sources. Process gas use is most common in petroleum refineries, certain chemical processing industries, and iron and steel mills. Coke is consumed mainly by iron and steel mills and foundries.

4.6 OTHER AREA SOURCES

Area sources yet to be discussed are forest fires, slash burning and prescribed burning, agricultural burning, structure fires, orchard heaters, leaking underground storage tanks, and natural organic sources. Although often intermittent in nature, many of these sources can produce large quantities of air pollutant emissions. Some of these sources, such as orchard heaters and certain kinds of agricultural burning, are not active during the oxidant season. These area sources are discussed briefly in this section, along with techniques for making crude emission estimates.

4.6.1 FOREST FIRES

Organic emissions from forest fires in certain rural areas can be very large, at least in the short term. Estimates of the quantity and types of growth burned in a given area should be available from the U.S. Forest Service, state forestry or agriculture departments, or local fire protection agencies. If local estimates are not available, the U.S. Forest Service annually publishes Wildfire Statistics, which gives the total acreage burned for each state.[67] However, this document does not provide burned acreage by county, so local fire and forestry officials should be consulted for estimates. If sufficient information cannot be obtained from local officials, the state total from Wildfire Statistics should be apportioned to counties according to forest acreage per county. If this information is not available from the appropriate state or local agency, the total acreage burned can be divided equally among counties with significant forest acreage, as shown on state maps.

The determination of tons of growth burned per acre ("fuel loading") is equally important. Local officials should be contacted for this information. The emissions in the study area are then obtained by multiplying the appropriate emission factor for VOC, NO_x, or CO in AP-42 by the fuel loading, then multiplying this product by the amount of forest acreage burned.

Average fuel loadings, emission factors, and estimates of organic emissions from forest fires in the various U.S. Forest Service Regions are presented in Section 11.1 in AP-42.

4.6.2 SLASH BURNING AND PRESCRIBED BURNING

Waste from logging operations is often burned under controlled conditions to reduce the potential fire hazard in forests and to remove brush that can serve as a host for destructive insects. Prescribed burning is used as a forest management practice to establish favorable seedbeds, remove competing underbrush, accelerate nutrient cycling, control tree pests, and contribute other ecological benefits.

Officials from the U.S. Forest Service and/or state forestry departments should be contacted for estimates of the area burned and the fuel loading (material burned per acre). If an estimate of the fuel loading cannot be obtained from these or other sources, a fuel loading factor of 75 tons per acre for slash burning and 3 tons per acre for prescribed burning can be used.

Prescribed burning can exhibit a seasonal and a diurnal variation. Determining when to burn a stand of trees may involve: selection of the year to burn; selection of the proper stage in the growing cycle, which means the proper season of the year; and selection of the times when favorable weather and fuel moisture conditions prevail.[68] Local or state officials should be contacted to determine when prescribed burning is most likely to occur in a given area. The emission inventory can then be adjusted accordingly.

4.6.3 AGRICULTURAL BURNING

This source category covers agricultural burning practices used to clear and/or prepare land for planting. Operations included under this category are stubble burning, burning of agricultural crop residues, and burning of standing field crops as part of harvesting (e.g., sugar cane). Little published information is available on this subject, so burning activity estimates must be determined through state agriculture departments or extension services.

Average fuel loadings and organic emission factors for various wastes are provided in Section 2.4 of AP-42. In some cases, agricultural burning may be reported under residential open burning.

4.6.4 STRUCTURE FIRES

Building fires can also produce short term emissions of organic compounds. The best procedure for determining information for this source category is to contact local fire departments, fire protection associations (e.g., the National Fire Protection Association), and other agencies for an estimate of the number of structure fires in each county during the year. In the absence of such information, an average of six fires per 1,000 people per year can be assumed.[69]

Estimates of the material burned is obtained by multiplying the number of structure fires by a fuel loading factor of 6.8 tons of material per fire.[70] Emission factors for VOC, NO_x, and CO can be obtained from the OAQPS Technical Tables.[71]

4.6.5 ORCHARD HEATERS

In areas where frost threatens orchards, heaters may be used in cold portions of the growing season. County or state agriculture departments will often have data on the number and types of orchard heaters in use. Data can also be obtained from some of the citrus grove operators in the area. These sources should also be able to furnish the period of time the units are fired during the year. An estimate should also be obtained of the number of units fired at any one time. These data may be used to determine heater hours of operation. Emission factors for orchard heaters are presented in Chapter 6 of AP-42. Since the use of heaters does not coincide with the usual months of high ozone formation, this source will be of little concern. However, in some locales, fueled heaters may be left in the orchards for major portion of the

year. This practice will increase evaporative emissions and should be accounted for in the inventory.

4.6.6 LEAKING UNDERGROUND STORAGE TANKS

It is estimated that in the United States between 100,000 and 400,000 underground storage tanks (UST) may be leaking. Many of these tanks are over 15 years old and are constructed of steel, which may rust over time. The underground piping connected to these tanks also has the potential to leak. Leaking UST are of concern because they may result in the contamination of drinking water, subsurface soils, and ground and surface water, and may emit toxic and/or explosive vapors. The contaminated soil and water may themselves emit VOC.

Although there are currently no national regulations in place for limiting emissions from leaking UST, research necessary to support estimates of emissions from leaking UST and from contaminated soil and water are under development.[72] If a leaking UST is treated as a small point source, emissions from the tank and the area immediately surrounding it can be estimated from actual monitoring of the site and/or from remediation activities.

Remediation can be accomplished by various methods including: soil venting, air stripping of VOC in water, soil aeration, product recovery, and carbon adsorption. Each of these methods accounts for initial and final contaminant levels. Many states require monthly reports containing initial and final contaminant levels in order to monitor the progress of remediation. By noting the length of time over which remediation takes place and by adding up the contaminant level emitted over time, an estimate can be made of emissions from a particular site.

4.7 MOBILE SOURCES

For inventory purposes, this category is broken down into highway and nonhighway sources. Highway vehicles included automobiles, buses, trucks, and other vehicles traveling on established highway networks. In contrast, nonhighway sources consists of mobile combustion sources such as railroads, aircraft, marine vessels, off-road motorcycles, snowmobiles, farm equipment, construction equipment, industrial equipment, and lawn and garden equipment.

Inventory methods of highway and nonhighway mobile source emissions are distinctly different. Highway vehicles are most often inventoried with traffic data compiled by transportation agencies. Development of a highway vehicle emission inventory can be divided into three main technical areas: development of transportation activity data, generation of vehicle emission factors, and use of appropriate emission calculation methods. Information on transportation activity in the area of concern is collected and processed into a suitable data base for use in emission estimation. Appropriate highway vehicle emission factors are generated. Emission factors and transportation activity data are then combined using appropriate calculation methods to produce an inventory suitable to the analytical level of the overall state implementation plan (SIP) process, within the constraints of the available data resources.

In most cases, transportation activity data development is based on transportation planning data at the most disaggregated level that can be obtained from the local metropolitan planning organization. Emission factors are generated using the current recommended version of the EPA MOBILE emission factor model.[73] At this writing, the current version of the EPA emission factor model is MOBILE3. Major revisions to the MOBILE model are expected to be included in an updated MOBILE4. Availability of MOBILE4 and descriptive documentation is projected for early 1989. This updated MOBILE4 is being produced especially for use in the upcoming ozone SIP preparation cycle. It will include capabilities for estimating diurnal and RVP-specific evaporative emissions, on-board evaporative emission controls, RVP control programs, and other new options not available in the currently documented MOBILE3. The MOBILE4 manual and additional SIP guidance will be necessary for state implementation of these new capabilities and for the definition of national-level VOC control programs which should be assumed in SIP analyses, such as gasoline marketing controls.

Inventory methods for nonhighway vehicles vary depending on the source. Aircraft emissions, for example, are generally based on the number of landing and takeoff (LTO) cycles performed. Aircraft emission factors can be expressed either in terms of the quantity of organics emitted per LTO cycle or of the quantity of organics emitted per hour in each mode of LTO operation. Railroads, marine vessels, off-highway motorcycles, and various types of equipment are often inventoried by determining fuel use. Emission estimates are based either on the total amount of fuel used or on total work output. AP-42 is commonly used to provide emission factors for nonhighway mobile sources.[73]

Off-highway internal combustion engines are both gasoline and diesel fuel-powered. The first category includes farm tractors, lawnmowers, motorcycles, and snowmobiles. The latter category also includes farm tractors as well as construction equipment, emergency generator power units, and compressor engines. While each of these source categories may be relatively small in many areas, their collective emission rates can be significant.

The following publications should be referred to for guidance on inventorying mobile sources:

- AP-42, Volume II: Mobile Sources[73]
- Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources[74]
- Users' Guide to MOBILE3[75]
- How to Perform the Transportation Portion of Your State Air Quality Implementation Plan[76]
- Guidelines for Review of Highway Source Emission Inventories for 1982 State Implementation Plans[77]

- **Example Emission Inventory Documentation for 1982 Ozone State Implementation Plants (SIPs)**[78]

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5.0 QUALITY ASSURANCE

5.1 PURPOSE

Quality assurance (QA) procedures are used to ensure that data meet a specific level of quality. QA is the result of planning and implementing steps to ensure and document data quality. A well-designed QA program promotes user/agency confidence in the data, provides a better assessment of emission inputs to air quality models, and lowers program costs for subsequent data base maintenance.

Conventional QA procedures defined by EPA govern the acquisition and analysis of environmental measurements. These procedures commonly address the fundamental concepts of data accuracy (assessing the difference between measured and true values). Emission inventories are based on emission estimates, and QA procedures actually involve checking the comprehensiveness and reasonableness - not the accuracy or precision - of the data.

QA functions in both preventive and corrective manners. It is important to identify the component processes of an inventory effort, estimate the potential locations and impacts of errors, and develop techniques to control (i.e., prevent) and correct errors. Errors can occur in the inventory process as well as in the data.

5.2 GENERAL PROCEDURES

A QA program applied to an emission inventory would have three general types of procedures:

- Standard operating procedures
- Error identification and correction techniques
- Product quality and reliability determinations.

These three procedures operate during the four phases of the emission inventory process previously discussed: planning, data collection and analysis, data handling, and data reporting.

Standard operating procedures should be outlined during the planning effort. Properly designed standard operating procedures will serve a preventive role as well as to direct the corrective process. These procedures include organizational planning to designate resources and personnel to the QA process, personnel training, project planning, and development of step-by-step procedures for technical tasks. Designation of a QA coordinator at this time will aid in standard application of the QA procedures and establishment of communication lines. Communication of QA procedures to affected personnel is vital to the effort, and includes the development of standardized formats to report the results of the inventory and QA processes.

Identification and correction techniques for errors provide the quality control process for the data. These techniques include identification of

potential sources of error and an evaluation of their impacts so that proportionally greater resources can be focused on the errors with the greatest impact. The planning process locates checkpoints for optimal problem detection, and identifies provisions for timely correction of problems. The correction processes operate during the data collection and analysis and data handling procedures.

Product quality and reliability determinations, in the context of an emission inventory, include periodic review of the entire inventory process and development of standards against which to test the reasonableness of results. These procedures are useful in judging an inventory as well as in maintaining a data base. A system audit is advised to maintain efficient use of resources.

5.3 ERROR IDENTIFICATION AND CORRECTION

Two types of errors arise in a VOC inventory effort: errors in the actual data and errors in data processing. In order to identify potential errors, tests for comprehensiveness and reasonableness are used. Critical errors, i.e., those having the greatest impact on inventory results, should be the subject of the greatest QA emphasis. Comprehensiveness refers to the completeness of an inventory in terms of facilities, data, and currentness. Reasonableness encompasses the internal consistency of data elements and the validity of data based on standard ranges for each element. Typical errors and error sources are listed in Table 5.3-1.

Comprehensiveness checks are used to locate missing sources or missing data. Manual comparison with other inventories, permit data bases, or independently derived lists identifies sources which may be missing. Missing data elements can be discovered through manual spot checking of the raw and processed data, or identified through computerized edit routines.

Reasonableness checks involve compilation of standard parameter ranges and application of the ranges to the inventory data. A computerized data handling system is well-suited to this task. Where standard emission factors are used, a computerized system can compute and/or check emission calculations. Emission and inventory data can then be screened for missing data, implausible entries, and conformity of results with known data relationships. The National Air Data Branch (NADB), as part of the NEDS, has developed some 50 parameters and internal consistency checks for the NEDS inventory.[1] In addition, ranges can be developed by using local/regional data and statistical tools to define typical ranges, or by applying staff experience and engineering judgment. If a computerized system is not available, spot checking can be used to locate errors or systematic problems. Table 5.3-2 shows valid heat contents by SCC, as found in NEDS. Tables 5.3-3 and 5.3-4 give NEDS control equipment codes and percent efficiency range by emission control equipment code, respectively.

Application of these techniques to locate and correct errors can occur throughout the inventory process. However, the QA process is more easily monitored and standardized when discrete points are chosen for the checks. Four easily identified milestones in the inventory process can serve as checkpoints; these also serve to formalize and document QA efforts:

TABLE 5.3-1. ERRORS AND ERROR SOURCES IN THE EMISSION INVENTORY PROCESS

Error	Potential sources	Related procedure category
Missing facilities or sources	Permit and inventory systems out of phase; errors in estimating potential emissions; lost paperwork; problems with computer file updates	All categories
Duplicate facilities or sources	Name changes through corporate acquisitions; use of multiple data sources with different source numbering schemes	Data collection
Missing operating or technical data or pollutants	Ambiguous data request forms; intentional deletion by facility staff; inadequate followup procedures; inadequate project control, i.e., no tentative indication of inventory size	Data collection, task planning
Erroneous technical data	Misinterpretation of data request instructions; assumed units, faulty conversions, etc.; intentional misrepresentation by the facility; poor handwriting	Data collection
Improper facility location data	Recording coordinates of facility headquarters instead of the operating facility; inability of technicians to read maps; changes in UTM zones	Data collection, technical procedures
Inconsistent area source categories or point source sizes	Failure to designate inventory cutoffs	Task planning
Inaccurate or outdated data	Use of data without Quality Assurance or update policies	Task planning
Errors in calculations	Transcription of digits; decimal errors; entering wrong numbers on a calculator; misinterpreting emission factor applications; error in automated calculation system	Technical procedures

TABLE 5.3-1. ERRORS AND ERROR SOURCES IN THE EMISSION INVENTORY PROCESS (continued)

Error	Potential sources	Related procedure category
Errors in emission estimates	Imprecise emission factors; applying the wrong emission factor; errors in throughput estimates; improper interpretation of combined sources; errors in unit conversions; faulty assumptions about control device efficiency; ranges of sulfur/ash contents in fuels	Technical procedures
Reported emissions wrong by orders of magnitude	Recording the wrong SCC code for subsequent computer emission calculations; ignoring implied decimals on computer coding sheets; transposition errors; data coding field adjustment	Data recording and reporting

TABLE 5.3-2. VALID HEAT CONTENTS BY SCC[2]

(* indicates that any number is accepted)

SCC CODE	HEAT MIN	HEAT MAX	SCC CODE	HEAT MIN	HEAT MAX
101001**	20	30	103001**	20	30
101002**	18	30	103002**	16	30
101003**	10	20	103003**	10	20
101004**	145	160	103004**	145	160
101005**	130	150	103005**	130	150
101006**	850	1200	103006**	850	1200
101007**	0	1200	103007**	0	1200
101008**	24	35	103009**	7	20
101009**	7	20	103010**	85	110
101011**	0	18	103012**	10	30
101012**	10	30	103013**	100	160
101013**	130	160	10500105	130	150
102001**	20	30	10500106	850	1200
102002**	18	30	10500110	85	110
102003**	10	20	10500205	130	150
102004**	145	160	10500206	850	1200
102005**	130	150	10500209	7	20
102006**	850	1200	10500210	85	110
102007**	0	1200	201001**	130	150
102008**	24	35	201002**	850	1200
102009**	7	20	201009**	125	145
102010**	85	110	202001**	130	150
102011**	0	18	202002**	850	1200
102012**	10	30	20200301	120	140
102013**	100	160	202004**	130	150

TABLE 5.3-2. VALID HEAT CONTENTS BY SCC[2] (continued)

SCC CODE	HEAT MIN	HEAT MAX	SCC CODE	HEAT MIN	HEAT MAX
202005**	145	160	390007**	0	1200
202009**	125	145	390008**	24	35
203001**	130	150	390009**	7	20
203002**	850	1200	390010**	85	110
203003**	120	140	390012**	10	30
204*****	*	*	390013**	100	160
30190099	*	*	40201001	850	1200
30400406	130	150	40201002	130	150
30400407	850	1200	40201003	145	160
30500206	850	1200	40201004	85	110
30500207	145	160	50190005	130	150
30500208	130	150	50190006	850	1200
30600101	*	*	50190010	85	110
30600102	*	*	50290005	130	150
30600103	130	160	50290006	850	1200
30600104	700	1200	50290010	85	110
306009**	*	*	50390005	130	150
390001**	20	30	50390006	850	1200
390002**	16	30	50390010	85	110
390003**	10	20	50390097	*	*
390004**	145	160	50390098	*	*
390005**	130	150	50390099	*	*
390006**	850	1200			

For all SCC's not listed above, the heat content should be zero.

TABLE 5.3-3. POLLUTION CONTROL EQUIPMENT IDENTIFICATION[2]

ID Number	Control Device/Method
000	No equipment
001	Wet Scrubber - High Efficiency
002	Wet Scrubber - Medium Efficiency
003	Wet Scrubber - Low Efficiency
004	Gravity Collector - High Efficiency
005	Gravity Collector - Medium Efficiency
006	Gravity Collector - Low Efficiency
007	Centrifugal Collector - High Efficiency
008	Centrifugal Collector - Medium Efficiency
009	Centrifugal Collector - Low Effficiency
010	Electrostatic Precipitator - High Efficiency
011	Electrostatic Precipitator - Medium Efficiency
012	Electrostatic Precipitator - Low Efficiency
013	Gas Scrubber (general, not classified)
014	Mist Eliminator - High Velocity, i.e., v>250 ft/min
015	Mist Eliminator - Low Velocity, i.e., v<250 ft/min
016	Fabric Filter - High Temperature, i.e., T>250 F
017	Fabric Filter - Medium Temperature, i.e., 180 F<T<250 F
018	Fabric Filter - Low Temperature, i.e., T<180 F
019	Catalytic Afterburner
020	Catalytic Afterburner with Heat Exchanger
021	Direct Flame Afterburner
022	Direct Flame Afterburner with Heat Exchanger
023	Flaring
024	Modified Furnace or Burner Design
025	Staged Combustion
026	Flue Gas Recirculation
027	Reduced Combustion - Air Preheating
028	Steam or Water Injection
029	Low-Excess - Air Firing

TABLE 5.3-3. POLLUTION CONTROL EQUIPMENT IDENTIFICATION[2]
(continued)

ID Number	Control Device/Method
030	Use of Fuel with Low Nitrogen Content
031	Air Injection
032	Ammonia Injection
033	Control of % O_2 in Combustion Air (Off-Stoichiometric Firing)
034	Wellman-Lord/Sodium Sulfite Scrubbing
035	Magnesium Oxide Scrubbing
036	Dual Alkali Scrubbing
037	Citrate Process Scrubbing
038	Ammonia Scrubbing
039	Catalytic Oxidation - Flue Gas Desulfurization
040	Alkalized Alumina
041	Dry Limestone Injection
042	Wet Limestone Injection
043	Sulfuric Acid Plant - Contact Process
044	Sulfuric Acid Plant - Double Contact Process
045	Sulfur Plant
046	Process Change
047	Vapor Recovery System (including condensers, hooding, and other enclosures)
048	Activated Carbon Adsorption
049	Liquid Filtration System
050	Packed-Gas Absorption Column
051	Tray-Type Gas Absorption Column
052	Spray Tower
053	Venturi Scrubber
054	Process Enclosed
055	Impingement Plate Scrubber
056	Dynamic Separator (Dry)
057	Dynamic Separator (Wet)

TABLE 5.3-3. POLLUTION CONTROL EQUIPMENT IDENTIFICATION[2]
(continued)

ID Number	Control Device/Method
058	Mat or Panel Filter
059	Metal Fabric Filter Screen (Cotton Gins)
060	Process Gas Recovery
061	Dust Suppression by Water Sprays
062	Dust Suppression by Chemical Stabilizers of Wetting Agents
063	Gravel Bed Filter
064	Annular Ring Filter
065	Catalytic Reduction
066	Molecular Sieve
067	Wet Lime Slurry Scrubbing
068	Alkaline Fly Ash Scrubbing
069	Sodium Carbonate Scrubbing
070	Sodium-Alkali Scrubbing
071	Fluid Bed Dry Scrubber
072	Tube and Shell Condenser
073	Refrigerated Condenser
074	Barometric Condenser
080	Chemical Oxidation
081	Chemical Reduction
082	Ozonation
083	Chemical Neutralization
084	Activated Clay Adsorption
085	Wet Cyclonic Separator
086	Water Curtain
087	Nitrogen Blanket
088	Conservation Vent
089	Bottom Filling
090	Conversion to Variable Vapor Space Tank
091	Conversion to Floating Roof Tank

TABLE 5.3-3. POLLUTION CONTROL EQUIPMENT IDENTIFICATION[2]
(continued)

ID Number	Control Device/Method
092	Conversion to Pressurized Tank
093	Submerged Filling
094	Underground Tank
095	White Paint
099	Miscellaneous Control Devices

For the particulate control devices (wet scrubbers, gravity collectors, centrifugal collectors, and electrostatic precipitators), the efficiency ranges correspond to the following percentages:

High:	95 - 99+
Medium:	80 - 95
Low:	< 80

TABLE 5.3-4. PERCENT EFFICIENCY RANGE BY EMISSION BY CONTROL EQUIPMENT CODE[2]

Cntrl. Equip. #	Valid for P.	S.	N.	V.	C.	% Efficiency Range: Part Min.	Part Max.	SO_2 Min.	SO_2 Max.	NO_x Min.	NO_x Max.	VOC Min.	VOC Max.	CO Min.	CO Max.
000	X	X	X	X	X	NOT VALIDATED									
001	X	X				95	99.9	75	97.0						
002	X	X				80	95.0	60	75.0						
003	X	X				70	80.0	30	60.0						
004	X					95	99.9								
005	X					80	95.0								
006	X					20	80.0								
007	X					95	99.9								
008	X					80	95.0								
009	X					20	80.0								
010	X					95	99.9								
011	X					80	95.0								
012	X					60	80.0								
013		X	X	X	X			70	99.0	70	99.0	70	99.0	70.0	99.0
014	X	X				70	99.9	70	99.0						
015	X	X				50	99.9	50	99.0						
016	X	X				75	99.9	20	80.0						
017	X	X				80	99.9	20	80.0						
018	X	X				80	99.9	20	80.0						
019	X			X	X	80	95.0					90	99.0	90.0	99.9
020	X			X	X	80	95.0					90	99.0	90.0	99.9
021	X			X	X	25	70.0					94	99.9	99.0	99.9
022	X			X	X	25	70.0					94	99.9	99.0	99.9
023	X			X	X	25	98.0					90	99.9	95.0	99.9
024			X							20	80.0				
025			X							20	60.0				
026			X							20	70.0				
027			X							20	60.0				
028			X							20	70.0				
029			X							10	60.0				
030			X							10	70.0				
031			X							10	80.0				

TABLE 5.3-4. PERCENT EFFICIENCY RANGE BY EMISSION BY CONTROL EQUIPMENT CODE[2] (continued)

Cntrl. Equip. #	Valid for P.	S.	N.	V.	C.	% Efficiency Range: Part Min.	Part Max.	SO_2 Min.	SO_2 Max.	NO_x Min.	NO_x Max.	VOC Min.	VOC Max.	CO Min.	CO Max.
032			X												
033			X							10	80.0				
034		X								10	80.0				
035		X						50	95.0						
036		X						50	95.0						
037		X						50	95.0						
038		X						50	95.0						
039		X						75	90.0						
040		X						75	90.0						
041		X						40	60.0						
042		X						80	90.0						
043		X						50	98.0						
044		X						95	99.9						
045		X						85	99.9						
046	X	X	X	X	X	10	90.0	10	90.0	10	90.0	10	90.0	10.0	90.0
047				X								85	99.0		
048				X								85	99.0		
049	X					50	99.9								
050	X	X	X	X	X	70	99.0	70	99.0	70	99.0	70	99.0	70.0	99.0
051	X	X	X	X	X	70	99.0	70	99.0	70	99.0	70	99.0	70.0	99.0
052	X	X	X	X	X	90	99.9	70	99.0	70	99.0	70	99.0	70.0	99.0
053	X	X	X	X	X	90	99.9	70	99.0	70	99.0	70	99.0	70.0	99.0
054	X					50	99.9								
055	X	X	X	X	X	20	99.0	20	99.0	20	99.0	20	99.0	20.0	99.0
056	X					20	99.9								
057	X					20	99.9								
058	X					10	95.0								
059	X					50	99.0								
060				X	X							95	99.9	99.0	99.9
061	X					00	99.9								
062	X					00	99.9								

TABLE 5.3-4. PERCENT EFFICIENCY RANGE BY EMISSION BY CONTROL EQUIPMENT CODE[2] (continued)

Cntrl. Equip. #	Valid for P.	S.	N.	V.	C.	% Efficiency Range: Part Min.	Part Max.	SO_2 Min.	SO_2 Max.	NO_x Min.	NO_x Max.	VOC Min.	VOC Max.	CO Min.	CO Max.
063	X					90	99.9								
064	X					90	99.9								
065			X												
066			X							75	99.9				
067		X								95	99.9				
068		X						50	95.0						
069		X						50	95.0						
070		X						50	95.0						
071	X					90	99.9	50	95.0						
072				X											
073				X								20	99.9		
074				X								20	99.9		
075	X					25	99.0					20	99.9		
076	X					50	99.9								
077	X					50	99.9								
080	X			X	X	20	99.9								
081			X									20	99.9	20.0	99.9
082				X						20	99.9				
083	X	X	X	X	X	10	99.9	10	99.9	10	99.9	10	99.9		
084				X								10	99.9	10.0	99.9
085	X					20	99.9					20	99.9		
086	X			X		10	95.0								
087				X								10	95.0		
088				X								10	99.9		
089				X								10	99.9		
090				X								10	99.9		
091				X								10	99.9		
092				X								10	99.9		
093				X								10	99.9		
094				X								10	99.9		
095				X								10	99.9		
099	X	X	X	X	X							10	99.9		

NOT VALIDATED

- Receipt of data - Returned inventories can be checked for missing or obviously questionable data.

- Emission calculations - When calculations for each facility are complete, both the computation and the results should be checked for accuracy and reasonableness.

- Compilation - When data is placed in the decided format, it should again be checked for transcription errors and reasonableness on a per facility basis.

- Assembly of data - When the data are brought together as an inventory, these should be checked again for completeness as well as for reasonableness.

5.4 PRODUCT QUALITY

Product quality is more difficult to assess in an inventory application than in a measurement application. It is essential in this assessment that errors and corrections have been documented. An inventory can be assessed by comparison with the results of previous inventories, and by compilation of missing and unvalidated data.

A powerful tool to improve product quality is a verification process that includes review by the inventoried facilities. If resources are available, emission data can be returned to facility contacts for review and comment. It may be appropriate to identify a subset of facilities, e.g., large emitters, to contact. In any case, user confidence can be increased by a verification step.

In the case of SIP emission inventory programs, EPA has developed a checklist for evaluation of submitted ozone inventories. This checklist will be available with the publication of "Emission Inventory Requirements for Post-1987 Ozone State Implementation Plans," and will contain an evaluation of QA including specific points regarding documentation.

5.5 SYSTEM AUDIT

In maintaining an inventory, a periodic and complete review of the QA system is in order. The auditor examines QA procedures and their effectiveness, assesses technical and personnel resources, and takes steps to tune the QA process accordingly. User feedback should play an important role so that problems in collecting, applying, or reporting the data are reviewed. This could result in improved emission factors, data formats, retrieval options, etc.

5.6 APPLICATION OF QA PROCEDURES

A QA program is necessarily specific to the needs, resources, and goals of the individual agency and inventory purpose. Therefore, general guidelines on the content of a QA program have been included for the four inventory stages.

The principles listed below should be considered prior to implementing these tasks. (Items denoted by a * indicate logical check points.)

Planning:

- o Allocate resources for optimal QA.
- o Prepare a checklist of sources to be evaluated.
- o Account for significant VOC sources.
- o Identify critical data elements and impacts on results and utility of the inventory.
- o Review questionnaire design.
- o Schedule routine checking of calculations and data entry.
- o Prepare data checking programs incorporating standard range and missing data checks.
- o Maintain a separate QA staff with experience in data collection and analysis.
- o Plan audit procedures.

Data collection and analysis:

- o Use redundant identification of major sources.
- o Check questionnaire design based on response.
- * o Check data collected.
- o Check emission estimation methods and consistency of application.
- * o Check calculated results.
- o Initiate verification procedures.

Data handling:

- o Check data after conversion to inventory format.
- * o Check individual data entries for missing emissions, SIC codes, implausible operating data, etc.
- o Assign agency estimates for missing data on a consistent and documented basis.
- * o Review tabulated data for quality and identification of outliers.

Data reporting:

- o Check aggregation of emissions.
- o Check disaggregation of emissions.
- o Compare results with other inventories.

Additional information on QA concepts and principles is available from other publications (References 1 through 6). Before planning a QA program, the reader may want to obtain these references or contact the EPA Regional Office.

References for Chapter 5.0

1. AEROS Manual Series, Volume II: AEROS Users Manual, EPA-450/2-76-029, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1976.

2. AEROS Manual Series, Volume V: AEROS Manual of Codes, Fourth Edition, EPA-450/2-76-005-9, U.S. Environmental Protection Agency, Research Triangle Park, NC, November 1985.

3. AEROS Manual Series, Volume III: Summary and Retrieval, Second Edition, EPA-450/2-76-009a, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1977.

4. The Emissions Inventory System/Area Source User's Guide, EPA-450/4-80-009, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1980.

5. The Emissions Inventory System/Point Source User's Guide, EPA-450/4-80-010, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1980.

6. Rich Bradley, Joan Stredler, Hal Taback, "Improving Emission Inventory Quality - A QA/QC Approach," presented at the 73rd Annual Meeting of the Air Pollution Control Association, Montreal, Canada, June 22-27, 1980.

6.0 EMISSION CALCULATIONS

6.1 INTRODUCTION

After planning and data collection, the third basic step in the inventory is the calculation of emissions. This involves (1) an analysis of the point and area source data collected by the procedures outlined in the preceding chapters and (2) the development of emission estimates for each source. In some cases, test data will be supplied by the source. However, in most instances the agency will have to compute emissions using emission factors or material balance considerations. The following three sections discuss the making of emission estimates based on source test data, material balances, and emission factors.

In cases where no data have been obtained for certain point sources, the agency may choose to "scale up" the inventory to account for these missing sources indirectly rather than to spend extra effort in an attempt to get the necessary information directly from each source. Techniques for accomplishing this are presented in Section 6.6.

Because reactive, rather than total, VOC emissions are needed in inventories used in ozone control programs, nonreactive VOC must be excluded from the emission totals for each source category. Section 6.7 of this chapter presents procedures for excluding nonreactive VOC from the inventory.

Section 6.8 discusses the seasonal adjustment of annual emission inventories. Seasonally adjusted inventories are of interest because higher ozone concentrations are generally associated with the warmer months of the year, and because VOC emissions from some sources vary seasonally. Thus, since most inventories are developed for an annual period, seasonal adjustment may be desirable to emphasize the relative importance of VOC emissions during the warmer months constituting the ozone season. Section 6.9 provides guidance on determining emissions for a typical summer or ozone season day.

A necessary element in any control program is the projection inventory showing anticipated emissions at some future date(s). Generally, at least two such projection inventories are required: baseline and control strategy. More may be required if multiple strategies or alternative growth scenarios are to be evaluated. The calculation of projection year emissions is discussed in Section 6.10.

6.2 SOURCE TEST DATA

Another method of estimating a source's emissions is the use of test data obtained by the agency or supplied by the plant itself. The use of source test data reduces the number of assumptions regarding the applicability of generalized emission factors, control device efficiencies, equipment variations, or fuel characteristics. A single source test or series of tests, taken over a sufficiently long time to produce results representative of conditions that would prevail during the time period inventoried, will normally

account for most of these variables. The most nearly complete type of source testing is continuous monitoring.

Most source test reports summarize emissions for each pollutant by expressing them in terms of (1) a mass loading rate (weight of pollutant emitted per unit time), (2) an emission factor (weight of pollutant emitted per unit of process activity), or (3) a flue gas concentration (weight or number of moles of pollutant per some weight or volume of flue gas). Generally, when a mass loading rate or emission factor is provided, the resulting emission estimates can be easily calculated. For example, if the average VOC emission rate for the time period tested was 12 lbs/hr, and the source operated for 16 hrs/day, 350 days/year, daily emissions would be 12 x 16, or 192 lbs, and the annual emissions would be 192 x 350, or 67,200 lbs (34 tons). Or, if an emission factor of 5 lbs of VOC per ton of product was given, and the plant produced 160 tons of product per day for 100 days per year, annual emissions would be 5 x 160 x 200, or 160,000 lbs (80 tons).

If the source test results are expressed in terms of VOC concentrations, the emission calculations are more detailed. As an example, assume that VOC emissions are expressed as parts per million, as shown in Figure 6.2-1. In this case, the concentration measurements and the flow rate measurements are used to obtain mass loading rates. (A formula for determining mass loading rates is shown as part of the calculations in Figure 6.2-1.) Note that in this example, VOC emissions are expressed as toluene, and a molecular weight of 92 lbs/lb-mole is used in the mass loading rate formula. If the concentration were expressed in terms of another organic reference compound, the appropriate molecular weight would be used. When the mass loading rate (14.0 lbs/hr, in this example) has been determined, this rate can be used to establish an average control efficiency. The control efficiency value is necessary in order to apply a rule effectiveness factor in calculating a representative daily emission rate for the inventory. A rule effectiveness of 80 percent is applied in this example.

Two points should be noted when using source test data to calculate emissions. First, because source tests are generally only conducted over several hours or days, at most, caution is urged in using these data to estimate emissions over longer time intervals or for conditions different from those under which the tests were performed. Adjustments may be needed to account for differing conditions. Second, a source test supplied by a plant may not adequately describe a given facility's annual or seasonal operating pattern. In cases where such data are not included in the test reports, an operating rate will have to be obtained in order to make reliable annual or seasonal emission estimates. This is best done by contacting the plant and obtaining operating information for the period during which the test was conducted. Such information could be obtained from questionnaire data but may not be as accurate.

Source Test Example

A single-line paper coating plant has been subjected to an emission test for VOC emissions. The coating solvent is primarily toluene and the emission concentrations were measured as toluene. The data averaged for three test runs are as follows:

Stack flow rate (Q_s) = 10,000 scfm

Emission concentration (C_e) = 96 ppm (as toluene)

Fugitive emission capture (E_{ffcap}) = 90 percent (from RACT)

Other information needed to complete the calculations includes:

Plant operation = 16 hours/day, 312 days/year

Solvent input rate (M_i) = 500 tons/year

Rule effectiveness = 80 percent

The emission calculation begins with determination of the average mass loading rate (M_o):

$$M_o = (1.58 \times 10^{-7})(MW)(C_e)(Q_s)$$

$$= (1.58 \times 10^{-7})(92)(96)(10{,}000)$$

$$= 14.0 \text{ lb/hr}$$

where: 1.58×10^{-7} = units correction factor $\frac{\text{lbmole x min}}{\text{hr x ppm x scf}}$

MW = molecular weight of toluene (lb/lbmole)

The emission control efficiency (E_{ffcon}) is calculated:

$$E_{ffcon} = (M_i - M_o)/M_i$$

$$= [500 - (14)(16)(312)/2{,}000]/500$$

$$= 0.93 \text{ or } 93 \text{ percent control efficiency}$$

The daily emission rate (E_D) after applying rule effectiveness is:

$$E_D = M_i\,[1 - (E_{ffcap})(E_{ffcon})(RE)]$$

$$= 500\,[1 - (0.90)(0.93)(0.80)]$$

$$= 1{,}058 \text{ lb/day}$$

Figure 6.2-1. Example source test data and emission calculations.

6.3 MATERIAL BALANCE

If source test results are not available, the agency can, in some cases, use material balance considerations to estimate emissions. In fact, for some sources, a material balance is the only practical method to estimate VOC emissions accurately. Source testing of low level, intermittent, or fugitive VOC exhaust streams can be very difficult and costly in many instances. Emissions from solvent evaporation sources are most commonly determined by the use of material balances.

Use of a material balance involves the examination of a process to determine if emissions can be estimated solely on knowledge of specific operating parameters and material compositions. Although the material balance is a valuable tool in estimating emissions from many sources, its use requires that a measure of the material being "balanced" be known at each point throughout the process. If such knowledge is not available, and is therefore assumed, serious errors may result.

In the VOC emission inventory, a material balance is generally used to estimate emissions from solvent evaporation sources. This technique is equally applicable to both point and area sources. The simplest method of material balance is to assume that all solvent consumed by a source process will be evaporated during that process. For instance, it is reasonable to assume that, during many surface coating operations, all of the solvent in the coating evaporates to the atmosphere during the drying process. In such cases, emissions are simply equal to the amount of solvent applied in the surface coating (and added thinners) as a function of time. As another example, consider a dry cleaning plant that uses Stoddard solvent as the cleaning agent. To estimate emissions, the agency needs only to elicit from each plant the amount of solvent purchased during the time interval of concern, because emissions are assumed equal to the quantity of solvent purchased.

The assumption that makeup solvent equals emissions also holds in certain more complicated situations. If a nondestructive control device such as condenser or adsorber is employed, this assumption is valid to the extent that the captured solvent is returned to the process. Similarly, if waste solvent reclamation is practiced by a plant, by distillation or "boildown," this assumption will be applicable. Both of these practices simply reduce the makeup solvent requirements of an operation, and commensurately, the quantity of solvent lost to the atmosphere.

In the above discussion, the material balance is simplified because of the assumption that all of the consumed solvent evaporates and is emitted to the atmosphere. Situations exist where such an assumption is not always reasonable. For example, if a destructive control device such as an afterburner, incinerator, or catalytic oxidation unit is employed on the process exhaust, any VOC emissions will be either destroyed or so altered that one could not reasonably assume, without testing the exhaust downstream of the device, the characteristics and quantities of any remaining VOC material. As another example, degreasing emissions will not equal solvent consumption if the waste solvent is sold to a commercial reprocessor. In such a situation,

emissions will be the difference of solvent consumed and solvent in the waste sent to the reprocessor. As still another example, some fraction of the diluent used to liquify cutback asphalt is believed not to evaporate after application, but rather, to be retained in the pavement. The above examples show that, if one assumes total evaporation of all consumed solvent, overestimation of emissions will result in many cases.

Several other situations can complicate the material balance. First, not all of the solvent losses from certain operations such as dry cleaning or degreasing occur at the plant site. Instead, significant quantities of solvent may be evaporated from the waste solvent disposal site, unless the waste solvent is incinerated or disposed of in a manner, such as deep well injection, that precludes subsequent evaporation to the atmosphere. Generally, one can assume that much of the solvent sent to disposal sites will evaporate. The agency should determine whether some solvent associated with various operations evaporates at the point of disposal rather than at the point of use as these losses may occur outside of the area covered by the inventory.

Material balances cannot be employed in some evaporation processes because the amount of material lost is too small to be determined accurately by conventional measurement procedures. As an example, applying material balances to petroleum product storage tanks is not generally feasible, because the breathing and working losses are too small relative to the total average capacity or throughput to be determined readily from changes in the amount of material stored in each tank. In these cases, AP-42 emission factors, developed by special procedures, will have to be applied.[1]

6.4 EMISSION FACTORS

One of the most useful tools available for estimating emissions from both point and area sources is the emission factor. An emission factor is an estimate of the quantity of pollutant released to the atmosphere as a result of some activity, such as combustion or industrial production, divided by the level of that activity. In most cases emission factors are expressed simply as a single number, with the underlying assumption being that a linear relationship exists between emissions and the specified activity level over the probable range of application. Empirical formulas have been developed for several source categories that allow the agency to base its emission estimates on a number of variables instead of just one. The most important VOC emitters for which a number of variables are needed to calculate emissions are highway vehicles and petroleum product storage and handling operations. As a rule, the most reliable emission factors are those based on numerous and representative source tests or on accurate material balance.

The use of an emission factor to estimate emissions from a source necessitates that the agency have complete source and control device information. In many cases, including most combustion sources, the emission calculation merely involves the multiplication of the appropriate emission factor by the source activity, such as fuel combustion, for the time interval in question. If a control device is in place, an adjustment factor equal to (1 - fractional control device efficiency) should be multiplied by the

uncontrolled emission estimate to account for the effect of the device. In AP-42, as in most cases, emission factors typically represent uncontrolled emissions or emissions before the action of any control device.

When empirical formulas are available, more detailed computations may be needed to estimate emissions. As mentioned above, highway vehicles and petroleum product handling and storage operations are sources for which a number of variables must be considered in the emission calculations. The following is a sample calculation for an external floating roof tank.[2]

Problem

Estimate the total annual evaporative loss, in pounds per year, given the following information:

Tank description:	Welded, external floating roof tank in good condition; mechanical shoe primary seal; 100 ft. diameter; tank shell painted aluminum color.
Stored product:	Motor gasoline; Reid vapor pressure, 10 psi; 6.1 lbs/gal liquid stock density; no vapor or liquid composition given; 1.5 million bbl/yr average annual throughput.
Ambient conditions:	$60^{o}F$ average annual ambient temperature; 10 mi/hr average annual wind speed at tank site; assume 14.7 psia atmospheric pressure.

Solution

Standing Storage Loss - Calculate the standing storage loss from Equation 6.4-1 below:

$$L_s \text{ (lb/yr)} = K_s V^n P^* D M_v K_C \qquad \text{(Equation 6.4-1)}$$

The variables in Equation 6.4.1 can be determined as follows:

K_s = 1.2 (from Table 6.4-1, for a welded tank with a mechanical shoe primary seal)

n = 1.5 (from Table 6.4-1, for a welded tank with a mechanical shoe primary seal)

V = 10 mi/hr (given)

$V^n = (10)^{1.5} = 32$

$T_a = 60^{o}F$ (given)

$T_s = 62.5^{o}F$ (from Table 6.4-2, for an aluminum color tank in good condition and $T_a = 60^{o}F$)

RVP = 10 psi (given)

P = 5.4 psia (from Figure 6.4-1, for 10 psi Reid vapor pressure gasoline and $T_s = 62.5^oF$)

P_a = 14.7 psia (assumed)

$$P^* = \frac{\frac{5.4}{14.7}}{\left[1 + \left(1 - \frac{5.4}{14.7}\right)^{0.5}\right]^2} = 0.114$$

D = 100 ft (given)

M_v = 64 lbs/lb-mole (typical value for gasoline)

K_c = 1.0 (given)

W_v = 5.1 lbs/gal (approximated assuming $W_v = 0.08\ M_v$)

To calculate standing storage loss in lb/yr, multiply the K_s, V^n, P^*, D, M_v, and K_c values, as in Equation 6.4-1:

L_s(lbs/yr) = (1.2)(32)(0.114)(100)(64)(1.0) = 28,000 lbs/yr

<u>Withdrawal loss</u> - Calculate the withdrawal loss from Equation 6.4-2 below:

$$L_w(\text{lb/yr}) = (0.943)\frac{QCW_l}{D} \qquad \text{(Equation 6.4-2)}$$

The variables in Equation 6.4-2 can be determined as follows:

Q = 1.5×10^6 bbl/yr (given)

C = 0.0015 bbl/1000 ft^2 (from Table 6.4-3, for gasoline in a steel tank with light rust)

W_l = 6.1 lbs/gal (given)

D = 100 ft (given)

To calculate withdrawal loss in lb/yr, use Equation 6.4-2.

$$L_w\ (\text{lb/yr}) = \frac{(0.943)(1.5 \times 10^6)(0.0015)(6.1)}{100} = 129\ \text{lbs/yr}$$

TABLE 6.4-1. SUMMARY OF AVERAGE SEAL FACTORS (K_s) AND WIND SPEED EXPONENTS (n)

TANK/SEAL TYPE	K_s	n
WELDED TANKS		
1. Mechanical shoe seal		
a. Primary only	1.2	1.5
b. Shoe-mounted secondary	0.8	1.2
c. Rim-mounted secondary	0.2	1.0
2. Liquid mounted resilient filled seal		
a. Primary only	1.1	1.0
b. Weather shield	0.8	0.9
c. Rim-mounted secondary	0.7	0.4
3. Vapor-mounted resilient filled seal		
a. Primary only	1.2	2.3
b. Weather shield	0.9	2.2
c. Rim-mounted secondary	0.2	2.6
RIVETED TANKS		
a. Mechanical shoe primary only	1.3	1.5
b. Shoe-mounted secondary	1.4	1.2
c. Rim-mounted secondary	0.2	1.6

TABLE 6.4-2. AVERAGE ANNUAL STOCK STORAGE TEMPERATURE (Ts) AS A FUNCTION OF TANK PAINT COLOR

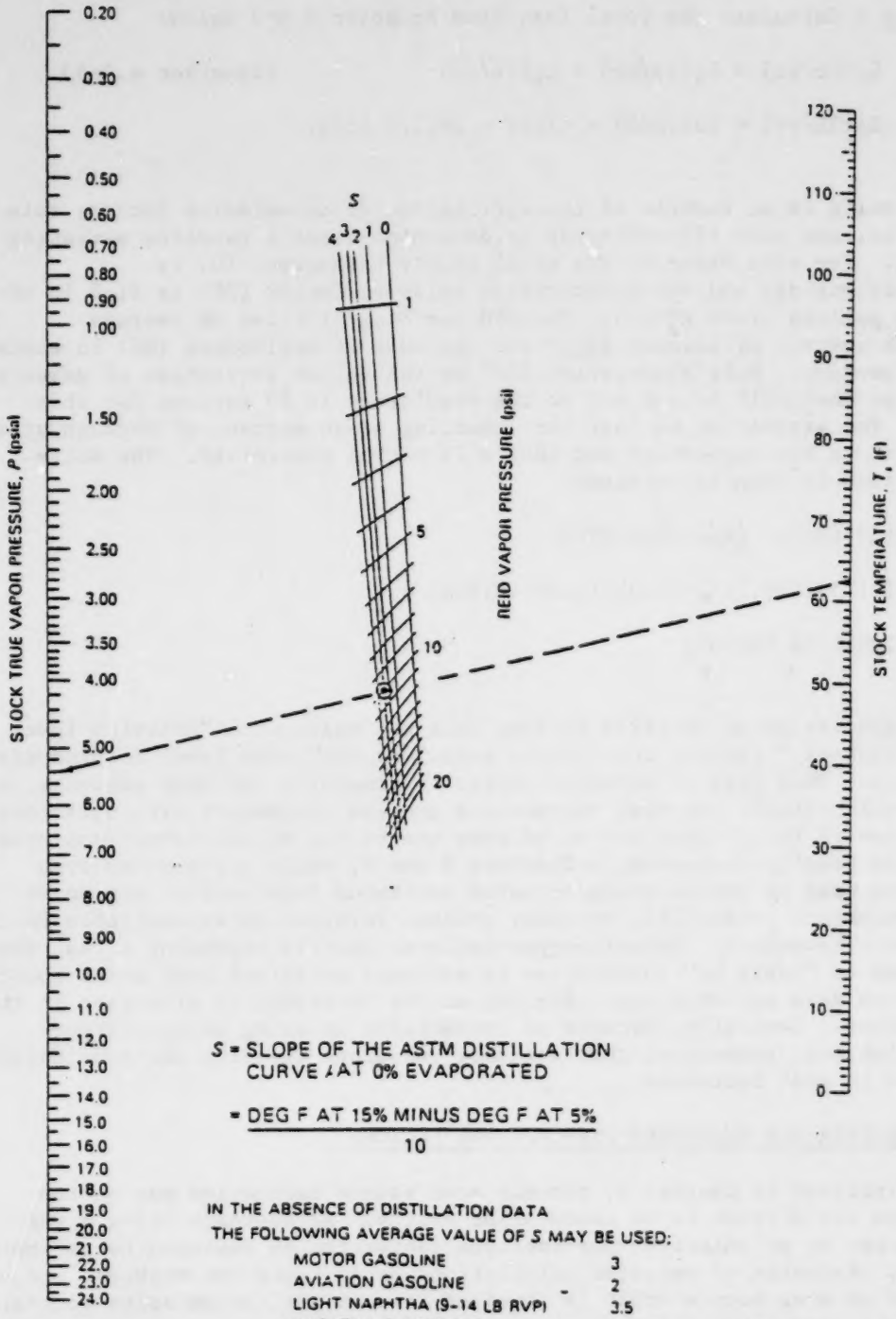
TANK COLOR	AVERAGE ANNUAL STOCK STORAGE TEMPERATURE, T_s (F)
White	T_a* + 0
Aluminum	T_a + 2.5
Gray	T_a + 3.5
Black	T_a + 5.0

*T_a is average annual ambient temperature in degrees Farenheit.

SOURCE: *Evaporation Loss from Fixed Roof Tanks*, Bulletin 2518, American Petroleum Institute, Washington, DC, June 1962.

TABLE 6.4-3. AVERAGE CLINGAGE FACTORS, C (bbl/1000 ft^2)

PRODUCT	SHELL CONDITION		
	LIGHT RUST	DENSE RUST	GUNITE-LINED
Gasoline	0.0015	0.0075	0.15
Crude Oil	0.0060	0.030	0.60



NOTE Dashed line illustrates sample problem for RVP = 10 pounds per square inch, gasoline stock (S = 3), and T_s = 62.5 F.
SOURCE: Nomograph drawn from the data of the National Bureau of Standards.

Figure 6.4-1. True vapor pressure (P) of refined petroleum stocks (1 psi to 20 psi RVP).

Total Loss - Calculate the total loss from Equation 6.4-3 below:

$$L_t(lb/yr) = L_s(lb/yr) + L_w(lb/yr) \qquad \text{(Equation 6.4-3)}$$

$$L_t(lb/yr) = (28,000) + (129) = 28,129 \text{ lb/yr}$$

Following is an example of the application of an emission factor, rule penetration, and rule effectiveness to determine Stage I gasoline marketing emissions. For this example, the total county throughput (Q) is 550,300 gallons/day and the uncontrolled emission factor (EF) is 11.5 lb of VOC/1,000 gallons (from AP-42). The CTG for Stage I cites an average 95 percent control efficiency (E_{ff}) and the rule effectiveness (RE) is assumed to be 80 percent. Rule penetration (RP) or the volume percentage of gasoline transferred that will be subject to the regulation is 93 percent for this example. The assumption is that the remaining seven percent of throughput is not subject to the regulation and thus will not be controlled. The daily emission rate is then calculated:

$$E = (EF)(Q)[1- (E_{ff})(RE)(RP)]$$

$$= (11.5)(550.3)[1-(0.95)(0.80)(0.93)]$$

$$= 1,856 \text{ lb VOC/day}$$

The discussion on emission factors thus has dealt with "activity level emission factors," factors that relate emissions with some level of production or capacity. This type of emission factor is generally the most accurate, as it physically relates the most appropriate process parameters with emissions. Another type of factor that can be of some use is the emissions-per-employee factor. As briefly discussed in Chapters 3 and 4, emissions-per-employee factors are used to obtain crude emission estimates from sources for which little equipment, production, or other process information is available in the point source inventory. Emissions-per-employee factors represent a tool that can be used to "scale up" inventories to estimate emissions from point sources for which no data are obtained. Scaling up for inventory is discussed in the next sections. Generally, because of imprecision in using emissions-per-employee factors, techniques that estimate emissions directly are considered preferable in most instances.

6.5 PER CAPITA AND EMISSIONS-PER-EMPLOYEE FACTORS

As discussed in Chapter 4, certain area source categories may be too numerous or too diffuse to be inventoried easily. An approach using a per capita factor or an emissions-per-employee factor can be employed to estimate emissions. Examples of emission calculations using these two methods, and an example of an area source which is required to meet certain emission control requirements, are given below.

Example 1. A per capita emission factor is used to calculate VOC emissions from architectural surface coating in a county with a population of 560,000.

Emissions = Population x Per Capita Factor

$$= 560{,}000 \times \frac{4.6 \text{ lb VOC}}{\text{capita/yr}} \times \frac{1 \text{ ton}}{2000 \text{ lbs}}$$

= 1,288 tons VOC/yr

A seasonal adjustment factor can be applied to determine the average emission rate adjusted to the peak ozone season. The seasonal adjustment factor for architectural surface coating, found in Table 6.8-1, is 1.3. When applied to the annual emissions value, the result is:

$$E_{ADJ} = (E_{ANN})(F_{SA})/AR$$

$$= (1{,}288)(1.3)/(7)(52)$$

= 4.6 tons VOC/peak ozone season weekday

where: E_{ADJ} = Adjusted emissions, tons VOC/peak ozone season weekday

F_{SA} = Seasonal adjustment factor

AR = Activity rate, days/year

More about seasonal adjustment factors application and development is described in Section 6.9.

Example 2. An emissions-per-employee factor is used to calculate VOC emissions from automobile refinishing. The number of employees in SICs 7531 and 7535 for the county is 672.

Emissions = Employment in SIC(s) x Emissions-per-Employee Factor

$$= 672 \times \frac{2.6 \text{ tons VOC}}{\text{employee/yr}}$$

= 1,747 tons VOC/yr

Example 3. New control procedures are required for perchloroethylene dry cleaning systems in the county. These controls will affect only commercial plants; coin-operated (self-service) plants will not be affected. From the CTG for perchloroethylene dry cleaning, an average reduction in emissions of 57.5 percent for

commercial plants is assumed. The population for the county is 482,700.

$$\text{Emissions} = (\text{Population} \times \overset{\text{Per Capita Factor}}{\text{Coin-Operated Plants}}) +$$

$$[\text{Population} \times \overset{\text{Per Capita Factor}}{\text{Commercial Plants}} \times (1.0\text{-reduction})]$$

$$= (482{,}700 \times \frac{0.3 \text{ lb VOC}}{\text{capita/yr}} \times \frac{1 \text{ ton}}{2000 \text{ lbs}}) +$$

$$(482{,}700 \times \frac{1.2 \text{ lb VOC}}{\text{capita/yr}} \times \frac{1 \text{ ton}}{2000 \text{ lbs}} \times 0.425)$$

$$= 72 \text{ tons/yr} + 123 \text{ tons/yr}$$

$$= 195 \text{ tons/yr}$$

6.6 SCALING UP THE INVENTORY

The preceding sections describe general techniques for calculating emissions based on data from questionnaires, source tests, and other methods. Although information should be obtained directly from as many sources as possible to enhance inventory accuracy, situations may arise where no data can be gathered from some segment of a source category. The pharmaceutical manufacturing industry is a case in point, with major manufacturers included as point sources and the multitude of small operations, usually employing less than 25 people, not even listed by many agencies. Auto refinishing presents a similar problem since operations are carried out on a fairly large scale by a few specialty shops and on a much smaller scale by numerous auto body shops. In these cases, the inventory can be "scaled up" to provide for a rough accounting of the missing emissions. To the extent that the resulting emission estimates are generally reported collectively, scaling up can be considered an area source approach. Any VOC source category is a potential candidate for scaling up.

The basic concept involved in scaling up an inventory is to use the data that have been received through plant contacts to extrapolate emission data for missing sources. The following formula shows the basic computation involved for a particular source category.

$$\text{Nonreported emissions} = \frac{\text{Reported Emissions}}{\text{Coverage Fraction}} - \text{Reported Emissions} \qquad \text{(Equation 6.6-1)}$$

Coverage fraction is a measure of the extent to which some indicator such as employment, number of plants, production, or sales is represented or "covered" by the questionnaire responses. Since reported emissions are known, and since nonreported emissions are sought in the above equation, the problem becomes one of determining the most appropriate indicator that can be used to estimate the fraction of coverage the agency's point source inventory did obtain.

The most commonly used coverage indicator for scaling up the inventory is the number of employees within pertinent Standard Industrial Classification (SIC) codes.[3] When employment within appropriate SIC categories is used as a measure of coverage, the above equation is transformed into the following relationship:

$$\text{Nonreported emissions} = \frac{\text{Reported Emissions}}{\text{Reported Employment}} \times \text{Total Employment} - \text{Reported Emissions} \quad \text{(Equation 6.6-2)}$$

In Equation 6.6-2, the ratio of reported emissions to reported employment is an emissions-per-employee factor. Equation 6.6-2 can be used in either of two ways to estimate missing point source emissions.

The recommended way to use Equation 6.6-2 is to derive values of both reported emissions and reported employment for each SIC category directly from the local point source data base. One advantage of this approach is that the resulting emissions-per-employee factors are tailored to the area of concern. One potential disadvantage is that the resulting factors, if based only on point source data, may not be representative of the smaller sources to which these factors will generally be applied. An example of this direct approach is given:

Example: Consider the situation of an area wherein five plants in SIC 3069 are coded as point sources, having combined annual emissions of 685 TPY of VOC. Based on employment data coded on the point source forms (or determined by plant contacts), these five sources employ 3,250 workers. According to <u>County Business Patterns</u>, 3529 persons are employed in SIC 3069 within the same area. Nonreported VOC emissions in SIC 3069 for this country can thus be calculated as:

$$\text{Nonreported emissions} = \left[\frac{685 \text{ TPY}}{3250 \text{ employees}}\right] \times 3529 \text{ employees} - 685 \text{ TPY}$$

$$= 59 \text{ TPY}$$

Hence, in this example, total emissions for the county in SIC 3069 would be estimated as 744 TPY. VOC emissions for the other SIC categories would be scaled up similarly. Note that in the above equation, the figure (685/3250) is an emissions-per-employee factor, equal to 0.211 ton/yr/employee.

The alternative to using values of reported emissions and employment directly from the local point source inventory is to apply emissions-per-employee factors that have been developed from inventory data in other areas. Examples of where this has been done are given in References 4 through 6. Ranges of emissions-per-employee factors for the more important industrial VOC sources are shown in Table 3.2-1 in Chapter 3. If, in the above example, an emissions-per-employee factor of 0.21 had been used from Table 3.1-1, Equation 6.6-2 then becomes:

Nonreported emissions = (0.21 TPY/employee x 3529 employees) - 685 TPY

= 56 TPY

One distinct advantage of using "borrowed" emissions-per-employee factors is that reported employment is not needed, which means that the technique can be used even where employment data are not collected for each point source. However, few emissions-per-employee factors are available in the literature, and an agency generally does not know what specific operations are covered by published factors. Hence, since the applicability of published emissions-per-employee factors to an agency inventory may be questionable, the agency should try to develop emissions-per-employee factors tailored to its own particular area. Moreover, these factors should be developed at the four digit level to prevent misapplication to employees not engaged in VOC emitting operations.

Regardless of whether locally developed or published emissions-per-employee factors are used, estimates of total employment within each industrial category are needed in order to use Equation 6.6-2. The most convenient source of employment is the U.S. Department of Commerce's publication County Business Patterns which summarizes employment, generally by county, for SIC categories at the 2, 3, and 4 digit level.[7] Other sources of industrial listings include state departments of labor/industry and various industrial directories. In some cases, employment in various categories will be determined as part of the ongoing transportation planning process in larger urban areas. The agency should determine which of these sources is most current and appropriate for estimating industrial coverage within its jurisdiction.

Extreme caution should be exercised when scaling up. This approach is necessarily somewhat crude, and should not be used to estimate the bulk of VOC emissions in an area. If the scaled up emission totals determined by this approach are significantly greater than the point source totals for the corresponding SIC categories, consideration should be given to expending more effort in the point source inventory, particularly for the more important source categories. Care should also be taken that any scaling up does not result in some inadvertent double accounting of emissions. Some portion of the resulting scaled up emission totals already may be accounted for by per capita emission factors or even by the application of other emission-per-employee factors to the same source category.

6.7 EXCLUDING NONREACTIVE VOC FROM EMISSION TOTALS

As was discussed in Section 2.2.8, a number of VOCs are considered photochemically nonreactive and thus should be excluded from the inventory used in the agency's ozone control program.[8,9] These nonreactive compounds are listed below:

Methane
Ethane
1,1,1-Trichloroethane (methyl chloroform)
Methylene chloride
Trichlorofluoromethane (CFC 11)

Dichlorodifluoromethane (CFC 12)
Chlorodifluoromethane (CFC 22)
Trifluoromethane (FC 23)
Trichlorotrifluoroethane (CFC 113)
Dichlorotetrafluoroethane (CFC 114)
Chloropentafluoroethane (CFC 115)

All of the above compounds, with the exception of methane and ethane, are halogenated organics. Halogenated organics find principal applications as metal and fabric cleaners, refrigerants, and propellants in aerosol products.

A major industrial category employing these halogenated compounds is degreasing, which is discussed in Section 4.3.2. To exclude these nonreactive VOC from the degreasing emission totals, the agency should elicit information on the particular type of solvent used in each degreasing unit. If information is obtained on the questionnaire or during the plant contact, the agency should experience little difficulty in excluding emissions of these nonreactive solvents from the resulting emission totals.

More difficulty is encountered when excluding nonreactive VOC from degreasers covered in the area source inventory, because numerous solvents will comprise the emission total. Several alternatives are available for determining an average degreasing solvent mix for area sources. One way is simply to summarize the solvent usage from the point source inventory and to apply the resultant mix to the area source total. Another alternative would be to conduct a brief survey of small degreasing facilities in the area. If either of these approaches is followed, a separate solvent mix should be determined for cold cleaning units and vapor degreasers and applied accordingly to the emission total for each degreasing category. If these procedures prove unworkable, nationwide data may be utilized. As an average, 75 percent of the solvent used in small cold cleaners is reactive, whereas only about 60 percent of the solvent used in vapor degreasing is reactive.[10] Because these averages may vary considerably from area to area and with time, local solvent mix data should be used, if reasonably available.

A small percentage of dry cleaning establishments use trichlorotrifluoroethane (FC 113) as a fabric cleaning solvent. Information on the type of solvent used at each dry cleaning plant should be obtained during plant contacts so that FC 113 emissions can be directly excluded. If dry cleaners are treated as area sources in the inventory, local survey results or other data will be needed to determine the FC 113 fraction of total cleaning solvent in the area. Nationwide, FC 113 is only used in about 5 percent of the coin operated units, and accounts for only about 0.4 percent of total annual dry cleaning solvent consumption.[11] Hence, in most situations, little error is involved if all dry cleaning solvent is assumed to consist of perchloroethylene and petroleum solvents.

Refrigerants present the largest application for fluorocarbons. The major fluorocarbons used in refrigerators, freezers, and air conditioners are fluorocarbons 11, 12 and 22.[12] Because these are all nonreactive, emissions

associated with refrigerant use need not be included in the VOC inventory used in an ozone control program.

Until the stratospheric ozone layer controversy, the largest percentage of fluorocarbons were used as aerosol propellants. Methylene chloride is also used as a propellent in aerosol products. Aerosol propellant use can be accounted for in the VOC inventory by using the per capita factor suggested in Section 4.3.8. Much of the propellent used in aerosol products is comprised of nonreactive halogenates, and should not be included in the inventory.[12,13]

The agency should be aware of several other end uses of these halogenated compounds that may be encountered in a VOC inventory. The bulk of all trichloroethane is used for metal cleaning, but a small fraction is found in polishes and waxes. This use is also discussed in Section 4.3.8. Similarly, methylene chloride is not only used for degreasing and in aerosol products, but is also used in paint removal operations and in the pharmaceutical industry. Likewise, fluorocarbons are also used as blowing agents to increase the insulation properties of urethane foams and used in plastic materials. To the extent that emissions from these various processes are known to be comprised of nonreactive VOC, they should be excluded from the inventory.[12,13]

All combustion sources emit methane and lesser amounts of ethane. Since source test data are generally not available for most combustion sources, to estimate the nonreactive fraction the agency will have to apply typical VOC species profiles to each source category. VOC profiles for many source categories are shown in Reference 14. An example VOC profile from this reference is shown in Table 6.7-1, representing carbon black production. Based on Table 6.7-1, methane and ethane make up 22.4 percent and 1.4 percent by weight, respectively, of all VOC emitted from this type of combustion. All of the other compounds are photochemically reactive. Hence, total emissions from this source would then have to be multiplied by the quantity [1-(0.224 + 0.14)], or 0.64, to determine the fraction that is reactive and that should be included in the inventory. Methane and ethane emissions can be excluded from other sources in the same manner. In general, no halogenated organics are emitted from combustion processes; hence, methane and ethane are the only two compounds to be considered for exclusion from the VOC inventory when dealing with combustion sources.

6.8 SEASONAL ADJUSTMENT OF THE ANNUAL INVENTORY

Most VOC emission inventories have traditionally contained estimates of annual emissions. Hence, all procedures, emission factors, correction factors, and activity levels employed in the inventory have been developed to represent annual average conditions. However, because high photochemical ozone levels are generally associated with the warmer months of the year, and because VOC emissions from some sources vary seasonally, the relative importance of VOC emissions should be determined during the warmer months constituting the ozone season. Peak ozone season for most areas of the country is May through September.

TABLE 6.7-1. VOC SPECIATION DATA FOR CARBON BLACK PRODUCTION

VOC Profile Speciation Report

Profile Name : Chemical Manufacturing - Carbon Black Production
Profile Number : 1002
Data Quality : D

Control Device : Uncontrolled
Reference (s) : 9
Data Source : Profile was developed from emissions data that were an average of six sampling runs at a representative plant.

SCC Assignments: 30100504,

Saroad	CAS Number	Name	Spec_MW	Spec_WT
43201	74-82-2	METHANE	16.04	22.40
43203	74-85-5	ETHYLENE	28.05	1.40
43204	74-98-8	PROPANE	44.09	0.20
43206	74-86-6	ACETYLENE	26.04	40.10
43212	106-97-7	N-BUTANE	58.12	0.20
43214	75-28-8	ISO-BUTANE	58.12	0.10
43933	433-58-8	CARBONYL SULFIDE	60.08	8.90
43934	75-15-5	CARBON SULFIDE	76.14	26.70
TOTAL				100.00

NOTE: Reference 14.

A seasonally adjusted inventory can be developed in various ways. One approach is to compile a separate inventory expressly for a typical day during the ozone season. This could entail the development of specific questionnaires, methodologies, seasonal emission factors, and correction factors for that typical day. This approach, while representing the ideal, would require more resources than are commonly available, especially if an annual inventory has already been compiled.

A more reasonable alternative is to use the existing annual inventory but, for the most important source categories, to adjust those variables affecting emissions to reflect conditions that prevail during the ozone season. This approach provides much of the seasonal specificity of the "typical day" inventory and does so with a minimal amount of effort. Because adjusting the existing annual inventory is preferable in many cases to developing an additional ozone-season-specific inventory, techniques for making such an adjustment are described below. Table 6.8-1 summarizes seasonal adjustments for area source categories.

The basic procedures for adjusting the annual inventory involve identifying those variables that influence emissions seasonally and substituting appropriate values that reflect conditions during the ozone season. Generally many parameters influence emissions as a function of time. Two of the most important variables are source activity and temperature.

6.8.1 SEASONAL CHANGES IN ACTIVITY LEVELS

Source activity for several important categories fluctuates significantly on a seasonal basis. Because VOC emissions are generally a direct function of source activity, seasonal changes in activity levels should be examined at the more important sources in the inventory. As an example, vehicle miles traveled (VMT) may increase in the summer in certain locations due to increased vacation or other travel, possibly leading to somewhat higher VOC emissions from highway vehicles during the summer months. Because of the importance of highway vehicles in many areas, the agency should determine VMT during the ozone season and should use this seasonal rate, rather than an annual average, for estimating emissions in the inventory. Similarly, the agency should determine if the activity at other important sources changes significantly throughout the year. Other operations that might be more active in the warmer months or, in some cases, active only during the warmer months, include exterior surface coating, asphalt paving, gasoline handling and storage, power plants, open burning, and pesticide applications. On the other hand, some sources, due to summer vacation shutdowns or decreased demand for the product, may be less active during the ozone season. Many sources, particularly industrial facilities, will show no strong seasonal change in activity. Little adjustment needs to be made in these cases to estimate the seasonal emissions component.

6.8.2 SEASONAL CHANGES IN TEMPERATURE

Another important variable is temperature, especially in that emissions from two of the most important VOC emission sources - highway vehicles and petroleum product handling and storage operations - are significantly

TABLE 6.8-1. AREA SOURCE SEASONAL ADJUSTMENT FACTORS FOR THE OZONE SEASON

CATEGORY	SEASONAL ADJUSTMENT FACTORS	ACTIVITY DAYS PER WEEK
Gasoline Service Stations		
Tank Trucks in Transit	Seasonal variations in through-put vary from area to area. Use average temperature for a summer day where appropriate.	6
Tank Truck Unloading (Stage I)		6
Vehicle Fueling (Stage II)		7
Storage Tank Breathing Losses		7
Solvent Users		
Degreasing	Uniform	6
Dry Cleaning	Uniform	5
Surface Coatings		
Architectural	1.3	7
Auto Refinishing	Uniform	5
Other Small Industrial	Uniform	5
Graphic Arts	Uniform	5
Cutback Asphalt	0	
Pesticides	1.3	6
Commercial/Consumer	Uniform	7
Waste Management Practices		
POTWs	1.4	7
Hazardous Waste TSDFs	1.2	7
Municipal Landfills	Uniform	7
Stationary Source Fossil Fuel Use		
Residential	0.3	7
Commercial/Institutional	0.6	6
Industrial	Uniform	6
Solid Waste Disposal		
On-Site Incineration	Uniform	7
Open Burning	Refer to local regulations and practices	7
Structural Fires	Uniform	7
Field/Slash/Prescribed Burning	0	
Wildfires	Refer to local fire conditions	7
Off-Highway Mobile Sources		
Agricultural Equipment	1.1	7
Construction Equipment	Uniform	6
Industrial Equipment	Uniform	6
Lawn and Garden Equipment	1.3	7
Motorcycles	1.3	7

influenced by temperature changes. As an example, breathing losses from fixed roof storage tanks increase at higher temperatures.

The following empirical formula and reference tables from Section 4.3 in AP-42 shows the dependence on these losses of temperature.[1]

$$L_B = 2.26 \times 10^{-2} M_v \left[\frac{P}{P_a - P}\right]^{0.68} D^{1.73} H^{0.51} T^{0.50} F_p C K_c$$

Where: L_B = fixed roof breathing loss (lb/day)

M_v = molecular weight of vapor in storage tank (lb/lb mole); See Note 1

P_A = average atmospheric pressure at tank location (psia)

P = true vapor pressure at bulk liquid conditions (psia); See Note 2

D = tank diameter (ft)

H = average vapor space height, including roof volume correction (ft); See Note 3

T = average ambient temperature change from day to night (^oF)

F_p = paint factor (dimensionless)

C = adjustment factor for small diameter tanks (dimensionless)

K_c = crude oil factor (dimensionless); See Note 4

Notes: (1) The molecular weight of the vapor, M_V, can be determined by Table 4.3-2 for selected petroleum liquids and volatile organic liquids or by analysis of vapor samples. Where mixtures of organic liquids are stored in a tank, M_V can be estimated from the liquid composition. As an example of the latter calculation, consider a liquid known to be composed of components A and B with <u>mole fractions</u> in the liquid X_a and X_b, respectively. Given the vapor pressures of the pure components, P_a and P_b, and the molecular weights of the pure components, M_a and M_b, M_V is calculated:

$$M_V = M_a \frac{P_a X_a}{P_t} + M_b \frac{P_b X_b}{P_t}$$

where: P_t, by Raoult's law, is:

$$P_t = P_a X_a + P_b X_b$$

(2) True vapor pressures for organic liquids can be determined from Figures 4.3-5 or 4.3-6, or from Table 4.3-2. In order to use Figures 4.3-5 or 4.3-6, the stored liquid temperature, T_S, must be determined in degrees Fahrenheit. T_S is determined from Table 4.3-3, given the average annual ambient temperature, T_A, in degrees Fahrenheit. True vapor pressure is the equilibrium partial pressure exerted by a volatile organic liquid, as defined by ASTM-D-2879 or as obtained from standard reference texts. Reid vapor pressure is the absolute vapor pressure of volatile crude oil and volatile nonviscous petroleum liquids, except liquified petroleum gases, as determined by ASTM-D-323.

(3) The vapor space in a cone roof is equal in volume to a cylinder, which has the same base diameter as the cone and is one third the height of the cone. If information is not available, assume H equals one half tank height.

(4) For crude oil, $K_C = 0.65$. For all other organic liquids, $K_C = 1.0$.

In the above formula, note that P, the true vapor pressure for a typical gasoline (RVP = 10), ranges from about 5.2 psia at a bulk liquid temperature of 60°F to 8.1 psia at 85°F. For this example, assume P_A is 14.7 psia (1 atmosphere). Hence, the term $[P/(14.7-P)]^{0.68}$ varies from about 0.66 to 1.15 over this range of bulk liquid temperatures. (Be aware that bulk liquid temperatures typically will exceed average ambient temperatures by several degrees, depending on tank color.[2]) This increase of about 70 percent demonstrates that evaporation potentially can be much more significant at higher summer temperatures. Thus, to adjust the inventory to estimate breathing loss emissions from fixed roof storage tanks during the ozone season, the agency should incorporate the appropriate temperature into the above formula to account for increased evaporation during warmer months. Temperature effects have to be accounted for in other petroleum product marketing and storage operations, as well. The effects of temperature on emissions from these other sources are also presented in Chapter 4 of AP-42. The reader should note that the empirical formulas for calculating storage tank losses are subject to change as a result of continuing testing programs. Hence, the most current AP-42 supplements should be consulted prior to making any storage tank calculations.

6.8.3 OTHER SEASONAL ADJUSTMENT CONSIDERATIONS

While source activity and temperature are two of the most important variables in determining seasonal fluctuations in the VOC emission inventory, other variables may be significant in certain instances. As an example, the use of air conditioning affects the magnitude of emissions from highway vehicles. As another example, emissions from floating roof tanks storing gasoline will depend on wind speed as well as on the Reid vapor pressure (RVP) of the gasoline. Typically, gasolines will have lower RVP in the summer, which tends to offset the increase in emissions expected if temperature were the only variable considered in the seasonal adjustment.[15]

For many sources, no major seasonal fluctuations in emissions are expected due to changes in process variables or ambient conditions. For example, some industrial surface coating operations such as metal parts painting may use the same amount of solvent in their operations in each season of the year. For these sources, no seasonal adjustment is necessary and the annual emission rate may be assumed equal to the emission rate during the ozone season.

6.8.4 DEVELOPMENT AND APPLICATION OF ADJUSTMENT FACTORS

Table 6.8-1 summarizes average seasonal adjustments for many area source categories. The table provides both adjustment factors and number of days of activity per week for the categories. Emissions for a typical summer or ozone season day can be determined by using the following equation:

$$\text{Emissions/Summer Day} = \frac{\text{Yearly Emissions} \times \text{Seasonal Adjustment Factor}}{\text{\# Activity Days per week} \times 52 \text{ weeks}}$$

The adjustment factors given in Table 6.8-1 are national averages. These factors will vary from area to area according to local conditions. An agency may want to alter the adjustment factors to represent local conditions. For example, the architectural surface coating adjustment factor is based on the assumption that 75 percent of the activity takes place over a seven-month period. If the agency feels that in its area 75 percent of the architectural surface coating activity occurs over ten months, the adjustment factor would be:

$$\frac{0.75}{10} \times 12 = 0.9$$

It is important to note that the adjustment factors for residential and commercial/institutional stationary source fossil fuel use do include heating.

If an agency wishes to develop its own seasonal adjustment factors (SAF), it must establish the peak ozone season (in number of months) for its area, choose the base year for its initial investigation, identify the point sources within the source category under consideration, and develop a questionnaire for the point sources. The questionnaire should request data for the base year including: annual process activity data; peak ozone season activity data; and the emission factor or estimate. The agency can then develop its own seasonal adjustment factor for the source category using the following equation:

$$\text{SAF} = \frac{(\text{Peak Ozone Season Activity})(12 \text{ months})}{(\text{Annual Activity})(\text{Peak Ozone Season months})}$$

This emission factor can then be applied to the annual activity information to estimate season emissions as the AP-42 factors are applied to estimate annual emissions. In establishing the peak ozone season for an area, other than the peak ozone season prescribed by EPA, an agency should consider congruity with adjoining areas, especially in interstate nonattainment areas.

6.9 DETERMINING EMISSIONS FOR A TYPICAL SUMMER DAY

Typical summer day emissions for a point source or an area source category can be determined by a variety of methods. As described in Section 6.8.4, the adjustment factors in Table 6.8-1 can be used to estimate emissions for a typical summer day for several area source categories. Area source activities associated with gasoline service stations can be adjusted by using summer temperature data in the appropriate equations.

Point source emissions estimates for sources whose emission factors and/or equations are temperature dependent should be adjusted using average daytime summer temperatures. Emissions that are dependent on production or throughput rate should be adjusted to reflect average operating rate during the summer period. Surveys or questionnaires sent to the facilities requesting annual process and emissions data should also request information on seasonal variations from those sources whose throughput or production are not uniform throughout the year. Also, information on days per week of normal operating schedule should be requested. Surveys requesting process data for a typical summer day should explain that the data should be averaged over one or more months during the summer season.

To determine emissions per day from emissions per year for facilities with uniform production or throughput throughout the year, the following equation can be used:

$$\text{Emissions/day} = \text{Emissions/year} \quad \frac{\text{(Operating)}}{\text{days/week}} \quad \frac{\text{(Operating)}}{\text{weeks/year}}$$

For sources with throughput that varies from season to season, the adjustment factor should be applied as in the following example.

Example: Annual emissions = 1.3 tons

Summer throughput = 28%

Summer adjustment factor = .28/.25 = 1.12

Operating schedule = 6 days/week

(1.3 tons/yr x 1.12 x 2000 lb/ton)/(6 days/wk x 52 wks/yr) =

9.3 lbs/day

Although mobile sources are addressed only to a limited extent in this document, it should be noted that emissions for highway mobile sources are estimated on a daily basis using seasonally specific inputs for vehicle miles traveled (VMT) and other conditions.

6.10 EMISSION PROJECTIONS

Projection inventories are needed by an agency to determine if a given area will achieve or exceed the ozone standard in future years. There are

two basic types of projections, baseline and control strategy. Baseline projections are estimates of future year emissions that take into account both expected growth in an area and air pollution control regulations in effect at the time the projections are made. Included are regulations which have been adopted and will take effect at a future date. Control strategy projections, on the other hand, are estimates of future year emissions that also include the expected impact of changed or additional control regulations.

Baseline projection inventories of countywide emissions for the particular years of interest will probably not be available from past inventory efforts. Moreover, whatever projection inventories that do exist may not reflect all of the growth and control scenarios that the agency may wish to evaluate. Hence, the agency will have to devote resources to the development of projection year inventories. Specific recommendations for making projections are discussed in the following sections. These general considerations should be kept in mind from the outset of inventory planning:

1. To a large extent, projection inventories will be based on forecasts of industrial growth, population, land use, and transportation. The air pollution agency should not attempt to make these forecasts but, rather, should rely on the local Metropolitan Planning Organization (MPO), Regional Planning Commission (RPC), or other planning agencies to supply them. This course has several advantages. First, it would be extremely costly for the air pollution agency to duplicate the forecasts made by other planning agencies. Second, the air pollution agency needs to base its emission projections on the same forecasts as other governmental planning agencies. This consistency is necessary to foster the credibility of any proposed control programs based on emission projections.

2. Anticipated control strategies being considered in the modeling area should be known in order to design projection inventories to reflect these strategies. This consideration may influence the type of data collected as well as the structure of the inventory itself. As an example, if the agency wants to test the effect of applying Stage I controls on tank trucks unloading only to service stations above a particular size, it may be desirable to treat these particular stations as point sources rather than to lump them in a general service station area source category.

3. It is important that all emissions projected for future years be based on the same methodologies and computation principles as the base year emissions. For example, if a traffic model is used for estimating travel demand for the base year, the same traffic model should be applied to estimate travel demand for projection years. Use of the same methodology assures consistency between base year and projection year emission estimates and prevents possibly spurious inventory differences from changes in methodology.

4. Projection inventories will always be open to question because of their speculative nature. The technical credibility of emission projections will be a function of their reasonableness, of the amount of research and documentation of assumptions, and of the procedures or methodologies used to make the projections. Some degree of uncertainty will always accompany

emission projections. This fact should be acknowledged openly. The art of projecting emission inventories is not in eliminating uncertainty, but in learning how to minimize it. Internal and external review of emission inventory projections will improve their technical quality and enhance their credibility.

6.10.1 MAJOR POINT SOURCE PROJECTIONS

The best approach for projecting emissions from major point sources is to obtain information on each facility. This type of projection information would ideally be determined by contacting plant management, but it could be solicited on questionnaires. Generally, questionnaires would not be sent out solely to obtain projection information, but this additional information may be elicited on questionnaires used in periodic updates of the baseline inventory. Permit applications submitted to various Federal, state, and local agencies should also be screened to get information on expected expansion or new construction. In addition, the local metropolitan planning organization and other planning bodies should be contacted for any information they may have on projected industrial expansion and for comment on the reasonableness of any plans submitted by plant personnel.

Once this type of projected plant growth information is obtained, the agency needs to determine what regulations will apply, in order to estimate controlled emissions. In the baseline projection, existing applicable regulations would be assumed and evaluated. For instance, a fossil fuel power plant now under construction and expected to start operation in two years would be subject to Federal New Source Performance Standards (NSPS) for particulate, SO_2, and NO_x emissions. Hence, unless plant personnel indicated that more stringent controls will be applied, the resulting emissions could reasonably be assumed to be equal to the standard. Similarly, the effects of any alternative standards would have to by evaluated. Since emission standards are commonly expressed in terms of emission factors, mass loading rates, or concentrations, the procedures outlined earlier in this chapter can be followed to estimate controlled emissions.

When obtaining projection information from plant management, the agency should inquire about increases in activity at the existing facility, at another existing plant, or at a new plant. The agency should determine if growth will result from expansion to existing capacity or from plant modifications to increase capacity. These considerations are especially important for major sources, since in certain areas new emissions may be limited by growth allocations. Such information will also help the agency to determine what additional control measures are likely to be required. The completion dates of any expansion or new construction are also needed in order to determine if emissions from a given source will affect the projection inventory.

As an example of making point source projections for specific sources, consider a facility employing a large open top vapor degreasing operation that emitted 100 tons of solvent per year in 1987, based on an annual production of 10,000 units of a particular metal part. Assume that no control measures are being taken to reduce solvent losses from the process. Suppose a plant contact

is made, and it is learned that 5 percent more metal parts will be produced per year until 1992 using the existing operation, and that, in 1996, a replacement facility will be brought on line at another location to produce 20,000 parts per year. Moreover, suppose that the source is located in an ozone attainment area where RACT is not required on VOC sources. To estimate VOC emissions from this source for a 1992 projection inventory, one could assume that, since no additional controls are expected, the current emission level can be multiplied by the cumulative growth rate in metal parts production (i.e., 5 years at 5 percent/year = $[1.05]^5$ = 1.28, or 128 percent) to estimate 1992 VOC emissions. In this manner, emissions for 1992 can be estimated at 128 percent of 100, or 128 tons per year, and the point source record for this projection year should be adjusted to take this growth into account.

To continue this example, suppose a control strategy projection is desired for 1998 to evaluate the effect of RACT as an alternate control strategy. In this case, both growth and controls must be considered. As a first approximation, if a similar open top vapor degreasing operation is used in the new facility, one can assume that, since 1998 production is twice 1987 production, uncontrolled emissions from the replacement plant will be twice those of 1987, or 200 tons per year. Since the new plant will be subject to RACT in this control scenario, VOC emissions will be reduced 45 to 60 percent from the uncontrolled case.[10] Hence, projected emissions in 1998 would be only 80 to 110 tons per year, depending on which RACT measures were instituted. Note that, since the replacement facility is to be built between 1987 and 1998, a new point source should be included in the 1997 projection inventory, and the old source deleted or assigned zero emissions in the projected year.

As is obvious from this example, even when projection information is available for specific facilities, certain assumptions will be necessary to project emission levels for some future year. For instance, in the 1992 baseline projection, it was assumed that emissions would increase proportionally with production. This may not be entirely accurate depending on the nature of the operation. This same assumption, along with an assumed emission reduction due to RACT, was also used in making the 1997 control strategy projection. This underscores the point made previously that projections are somewhat speculative in nature.

6.10.2 AGGREGATE POINT SOURCE PROJECTIONS

In many instances, projection information will not be available on every facility in an area of interest. Some plant managements will not be willing or able to provide forecasts of their corporate plans, especially for distant years. In addition, many plants in certain source categories, such as small industrial boilers, will be too small and too numerous to warrant the individual solicitation of projection information. In these situations, other procedures need to be employed to project future emissions. Two possible approaches are discussed below.

In the case of large point sources, projection information may be available on many sources within a given category, but for various reasons, may not be obtainable for one or more facilities. For example, 10 paint

manufacturing plants may operate in the area of interest, but successful contacts may have been made with only eight of these. In this situation, a reasonable approach to projecting growth and emissions at the remaining two plants would be to evaluate the growth trends in the plants for which projections are known and to apply them to the plants for which no information is available. In the example of the paint manufacturing plants, if production were expected to expand by 6 percent per year, on average, for the eight plants, then this rate could be applied to the two plants to estimate expected growth. Then, with the increase in production known, the appropriate control measures would be considered in making a baseline projection. Good engineering judgement is needed in this practice to screen out any unreasonable projections that may occur.

For smaller point sources, obtaining projection information from each plant may not be feasible. In these cases, the rate of activity growth may be assumed to be equivalent to that of some surrogate indicator for which projections have been made by local MPOs or by OBERS.[16] For example, one might assume that cold cleaning operations would grow at the same rate as that of industrial manufacturing, which can, in turn, be estimated from projections of employment in industrial manufacturing categories.

Regardless of what surrogate indicators are used for making projections, the basic calculations are the same. The ratio of the value of the surrogate indicator in the projection year to its value in the base year is multiplied by the aggregate base year activity level for the point source category in the base year. Because the projection years of interest to the air pollution control agency will not often be the years for which growth projections have been made, interpolation of projection year data may be required. Local planning agency input should be sought regarding whether straight line or other interpolation methods should be employed.

6.10.3 AREA SOURCE PROJECTION PROCEDURES

Two approaches can be used for making growth projections of area source emissions. The more accurate approach involves projecting the activity levels themselves. The more common approach, however, involves the use of surrogate growth indicators to approximate the increase or decrease of each activity level.

The first of these approaches is generally employed when a local survey has been made or when other local estimates projecting growth in specific areas are available. For example, if a survey of dry cleaners has been performed, and the average growth in the modeling area is projected to be 5 percent per year, then in 5 years, dry cleaning activity would increase by 28 percent.* As another example, a local asphalt trade association may be able to project area cutback asphalt use in a future year. When considering such estimates, the inventorying agency must recognize the possibility of deliberate or inadvertent biases, through wishful thinking or self-serving motives, and it should strive

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*$(1.05)^5 = 1.28$, or a 28 percent increase

to obtain opinions which are as objective as possible. Moreover, the agency should be careful to determine whether or not such estimates of future activity levels anticipate the effect of control measures. This is important, as some estimates may be used more appropriately in control strategy projections than in the baseline inventory. Any such projections should be consistent with projections made by other planning agencies.

A common alternative to projecting activity levels directly is using indicators of growth. In the context of projections, a surrogate growth indicator is one whose future activity is fairly certain and is assumed to behave similarly to the specific activity levels of interest. The most commonly used surrogate growth indicators are those parameters typically projected by a local MPO such as population, housing, land use, and employment. As one example, the quantity of consumer/commercial solvent use in a projection year might be assumed to grow proportionally with population. Hence, if population in an area increased by 10 percent from the base year through the projection year, consumer/commercial solvent use could be assumed to increase by 10 percent, as well. Regardless of what variables are used as growth surrogates, the basic calculation is the same: the ratio of the value of the growth indicator in the projection year to its value in the base year is multiplied by the area source activity level in the base year to yield the projection year activity level.

In making area source emission projections, control measures will have to be considered for certain source categories. The effects of controls on area sources can generally be simulated by changes in either emission factors or activity levels, depending on the source and the nature of the control measure(s) being considered. As an example of the first of these approaches, RACT for gasoline service stations could be accounted for by using an emission factor lower than the uncontrolled factor given in AP-42.[17] As an example of the second approach, RACT for cutback asphalt paving could be evaluated by simply reducing the activity level in proportion to the fraction of cutback asphalt that would be replaced with emulsified asphalt.[18]

Projection information on several area source categories is summarized in Table 6.10-1.

6.10.4 PROJECTION REVIEW AND DOCUMENTATION

Because the projection inventories are so important in control strategy development, they should be reviewed in draft form by the air pollution control agency and as many other involved groups as possible. The projection inventories will survive this careful scrutiny if all assumptions, procedures, and data sources are carefully documented. This review and documentation process will help assure that the projections are (1) consistent with any other projections being made in the area, (2) objective and not biased toward any particular policy, etc., (3) open, with all assumptions and estimates clearly stated for public review, and (4) defensible because of all of the above.

The key aspects of projections that will invite criticism are: (1) which indicators are used for projecting activity level growth, (2) when and where this growth will occur, and concomitantly, whether it will occur by expansion

TABLE 6.10-1. GROWTH INDICATORS FOR PROJECTING EMISSION TOTALS FOR AREA SOURCE CATEGORIES[19]

Source Category	Growth Indicators	Information Sources
Gasoline handling	Gasoline demand, vehicle use (VMT), or population	U.S. Department of Transportation, state transportation agency, state tax agency, local MPO, or Reference 20
Dry cleaning	Population, retail service employment	Solvent supplier, trade association
Degreasing	Industrial employment	Trade association
Nonindustrial surface coating	Population or residential dwelling units	Local MPO
Cutback asphalt	Consult industry and local road departments	Consult industry and local road departments
Pesticide applications	Agricultural operations	State department of agriculture, local MPO
Miscellaneous solvent use	Population	Local MPO
Aircraft, commercial, and general	Projections should be done case by case; projected land use maps may be useful	Local airport authority, MPO, state aviation system plan
Aircraft, Military	Estimate on individual	Local airport authorities and appropriate military agencies
Agricultural equipment	Agricultural land use, agricultural employment	Local MPO
Construction equipment	Heavy construction employment (SIC code 16)	Local MPO

(continued)

TABLE 6.10-1. GROWTH INDICATORS FOR PROJECTING EMISSION TOTALS FOR AREA SOURCE CATEGORIES[19] (continued)

Source Category	Growth Indicators	Information Sources
Industrial equipment	Industrial employment (SIC codes 10-14, 20-39, and 50-51) or industrial land use area	Local MPO
Lawn and garden equipment	Single-unit housing or population	Local MPO
Off highway motorcycles, snowmobiles, and small pleasure crafts	Population	Local MPO
Railroads	Revenue ton-miles	References 21, 22
Ocean-going and river cargo vessels	Cargo tonnage	Local port authorities, U.S. Maritime Administration, or U.S. Army Corps of Engineers.
Residential fuel combustion	Residential housing units or population	Local MPO and Reference 23
Commercial/institutional fuel combustion	Commercial/institutional employment, population, or land use area	Local MPO, land use projections
Industrial fuel combustion	Industrial employment (SIC codes 10-14, 20-39, and 50-51) or industrial land use	Local MPO, land use projections
Solid waste disposal, on-site incineration, open burning	Based on information gathered from local regulatory agencies	
Fires: Managed burning, agricultural field burning, frost control (orchard heaters)	Based on anticipated local regulations as indicated by information sources	
Fires: forest wildfires, structural fires	Difficult to project - see Chapter 4	

of existing facilities or by new construction, and (3) what emissions will be associated with this growth, either in the baseline case or as a result of various candidate control strategies. When planning, compiling, and reviewing the point source projection inventory, the agency should focus particular attention on these issues.

It is especially important that consistent methodologies be used for the base year and the projection years to estimate emissions for each source. For example, if emissions from gasoline evaporation at service stations in a base year are estimated from the results of a special study based on questionnaires sent to individual service stations, it would be inconsistent to estimate such emissions for a future year based on projected VMT. Such inconsistencies will likely lead to changes in emission estimates that are due not to growth or control measures but, rather, to changes in the inventory procedures themselves.

A test to determine if the various base year and projection year methodologies are mutually consistent is to judge whether each projection year methodology, if applied to the base year data, would result in a replication of the base year emission totals. If significant discrepancies are found, then one methodology should be chosen to apply to both years. Generally, in this regard, any methodology which applies growth factors to the base year total to estimate projection year emissions or activity levels will meet this consistency criterion.

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7.0 SUPPORTING DOCUMENTATION AND REPORTING

7.1 INTRODUCTION

The final phase in the development of an emission inventory is presentation of the data which has been collected, compiled, and analyzed. The data can be presented in a variety of forms, from unorganized raw data listings to aggregate summary reports. Generally, the form in which the data will be presented is determined by (1) how the data can be most efficiently summarized, and more importantly, (2) why the inventory was conducted.

Documentation supporting the inventory is a necessary part of all summary reports. However, the degree of documentation, like the reporting format, will also depend on the end use of the inventory data. In this chapter, some examples of both inventory data presentation and documentation will be discussed, as well as how inventory end uses can determine both the presentation and the documentation.

7.2 REPORTING FORMS

The purpose of the emission inventory is the primary consideration in deciding on a reporting format. An inventory developed only for research purposes can be presented in many forms. For example, a raw data listing, which basically presents the data compiled in the inventory, could consist simply of computer printouts of sources and emissions. The printouts would require no additional preparations for agency internal use.

On the other hand, reports which are for use outside an agency will usually be more formal than reports for internal use. External use reports, such as public information pamphlets and emissions control program documents, require formatting which clearly presents summarized inventory data. Since these reports summarize the inventory data, they are referred to as summary reports.

A summary report includes information that has been aggregated and organized in some manner during the reporting process. For instance, a summary report of total VOC emissions from all dry cleaners in an area would of necessity involve a totaling of emission estimates stored in certain file records. In many instances, some analysis of the data might also be performed in the process of preparing a summary report. A more formal summary report will convey the inventory information clearly and concisely to the document reader.

An example of formal inventory reports are State Implementation Plan (SIP) submissions or other control strategy inventory reports. These reports must meet formatting requirements set forth in local, state and EPA regulations. Because requirements may differ for each agency as well as for different years, the most recent Federal Register or local administrative code should be consulted when reporting control program inventories. As a guide, reporting formats proposed for the post-1987 SIP submittals are shown in Appendix B. Table 7.2-1 gives VOC emission sources with their associated SIC(s).

TABLE 7.2-1. VOC EMISSION SOURCES WITH ASSOCIATED SIC(s)

VOC EMISSION SOURCE	SIC
Storage, Transportation and Marketing of VOC	
- Oil and Gas Production and Processing	1311, 1321, 1381-89, 2911-2999, 4925
- Gasoline and Crude Oil Storage	4226, 4612-19
- Synthetic Organic Chemical Storage and Transfer	4226
- Ship and Barge Transfer of VOC	4469
- Barge and Tanker Cleaning	4469
- Bulk Gasoline Terminals	5171
- Gasoline Bulk Plants	5171
- Service Station Loading (Stage I)	5541
- Service Station Unloading (Stage II)	5541
- Others	2999,4226
Industrial Processes	
- Petroleum Refineries	2911
- Lube Oil Manufacture	2992
- Organic Chemical Manufacture	2831, 2833, 2841, 2842 2861-68, 2891-99, 2999
- Inorganic Chemical Manufacture	2812, 2813, 2819, 2869, 2873-79
- Paint Manufacture	2816, 2851
- Fermentation Processes	2082-85
- Vegetable Oil Processing	2074-79
- Pharmaceutical and Cosmetic Manufacture	2833-36, 2841-44
- Plastic Products Manufacture	3079
- Rubber Tire Manufacture	3011, 7534
- SBR Rubber Manufacture	2822, 3021, 3041, 3069
- Textile Polymers and Resin Manufacture	2821, 2823
- Synthetic Fiber Manufacture	2823, 2824
- Iron and Steel Manufacture	3312-25
- Other Metal Manufacture	3331-99
- Others	2011-65, 2086-99, 2111-370, 2371-98

(continued)

TABLE 7.2-1. VOC EMISSION SOURCES WITH ASSOCIATED SIC(s) (continued)

VOC EMISSION SOURCE	SIC
Industrial Surface Coating	
- Large Appliances	3585, 3631-39, 3651
- Magnet Wire	3546, 3621, 3643
- Automobiles and Trucks	3711-15
- Can	3411
- Metal Coils	3444, 3449
- Paper	2621, 2641-3, 2647-9, 2654, 2655, 2673-79
- Paperboard	2631, 2645, 2646, 2651-3, 2657, 2661
- Fabric	2211-99, 2399, 2591
- Wood Products	2431-49, 2452, 2491-99 2511-21, 2531, 2541, 3995
- Metal Products	2522, 2542, 2599, 3412-89, 3494-9 3511-72, 3576-82, 3586-99
- Plastic Products	2821, 2823, 3074
- Large Ships	3731
- Large Aircraft	3721-28
- Others	3573, 3574, 3600-29, 3641-8, 3652-99, 3721-28, 3732-924, 3996-9
Nonindustrial Surface Coating	
- Architectural Coatings	7349
- Auto Refinishing	5511, 7532, 7538, 7539, 9621
- Others	4582, 8321, 9711
Other Solvent Use	
- Degreasing	All
- Dry Cleaning	7211-19
- Commercial Printing	2711-52, 2754, 2761, 2771, 2782 2789, 2791, 2799
- Other Graphic Arts	2753, 2795, 3993
- Adhesives	2434-39, 2451-99, 2511, 2512, 2517, 2521, 2531, 2677, 2789, 3021, 3061, 3088, 3142-99, 3711-99, 3812-73, 3911-99
- Cutback Asphalt/Asphalt Cement	2951, 2952
- Solvent Extraction Processes	
- Consumer/Commercial Solvent Use	4013, 5511, 5521, 5541, 7538
- Other	2371

(continued)

TABLE 7.2-1. VOC EMISSION SOURCES WITH ASSOCIATED SIC(s) (continued)

VOC EMISSION SOURCE	SIC
Other Miscellaneous Sources	
- Fuel Combustion	5812, 7391
- Solid Waste Disposal	4952, 9511
- Forest, Agricultural and Other Open Burning	0711, 0811-51
- Pesticide Application	7342
- Waste Solvent Recovery Processes	
- Stationary Internal Combustion Engines	
- Waste Management Practices	9511

In addition to required reporting formats, a wide variety of tables and graphic displays can be employed to present inventory data. Charts, tables, and graphs can quickly convey to the reader emission breakdowns by industries, geographical areas, or source size. Emission trends and the effects of control programs can also be tabulated or graphed. Several examples of tables and graphs are included here to provide some ideas on how data can be presented.

Figure 7.2-1 is an example of a pie chart illustrating the relative importance of VOC emission sources. Figure 7.2-2 is an example of how to show the relative importance of sources by bar graphs. Note that projection year emissions can be compared with base year emissions. Figure 7.2-3, an expansion of a sub-part of Figure 7.2-2, provides the reader with a detailed breakdown of organic solvent emissions by source type. Other figures and tables may be used if they illustrate the particular characteristics of an emission inventory.

How the inventory data can most efficiently be summarized will depend on time and manpower available to assemble a report. Tabular reports are the most common kind of report, as they can be readily generated from computerized inventory systems. Certain types of graphic displays, on the other hand, are difficult to produce using a computer and require time and manpower to develop by hand. Most of the NEDS raw data and summary reports available to the public are of the tabular variety. The various NEDS reporting programs are described in detail in Reference 1.

Summary inventory data tables, together with raw listings of equipment, activity levels, and emissions from individual sources, constitute the most frequently used reports in the development and implementation of an ozone control program. Because there exists a need at certain levels to be able to compare baseline inventories from one area to another, as well as to determine the impact of employing various control strategies, such as RACT, a common format is considered desirable to promote reporting consistency. The format presented in Appendix B is proposed for reporting of VOC, NO_x, and CO emissions in Post-1987 SIPs.[2] This format allows the agency to identify all major source categories of volatile organic compound emissions and to determine the reductions that may occur in an area if various control strategies are employed.

7.3 SUPPORTING DOCUMENTATION

Documentation of the emission inventory is highly useful for all inventory uses. While inventories developed for internal use may not require the same degree of documentation as inventories used in SIPs, good documentation of all inventories will help an agency when more formal inventories must be developed. Therefore, compiling and maintaining documentation in support of data are recommended in all emission inventories. Reference 3 should be referred to for examples of emission inventory documentation.

Documentation entails keeping a record of all methods, assumptions, example calculations, references, and results employed in the compilation effort. The goal of documentation is to be able to explain to both the agency

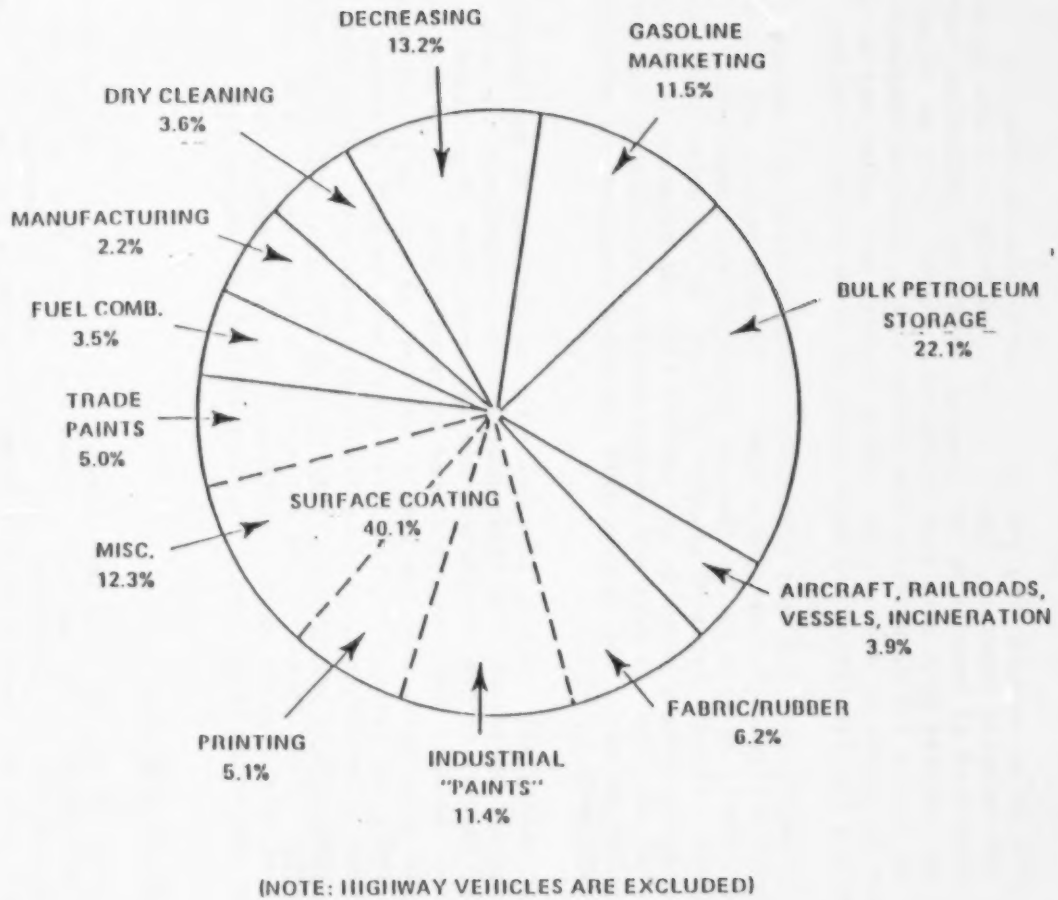


Figure 7.2-1. Example pie chart to illustrate source category contributions to total emissions.

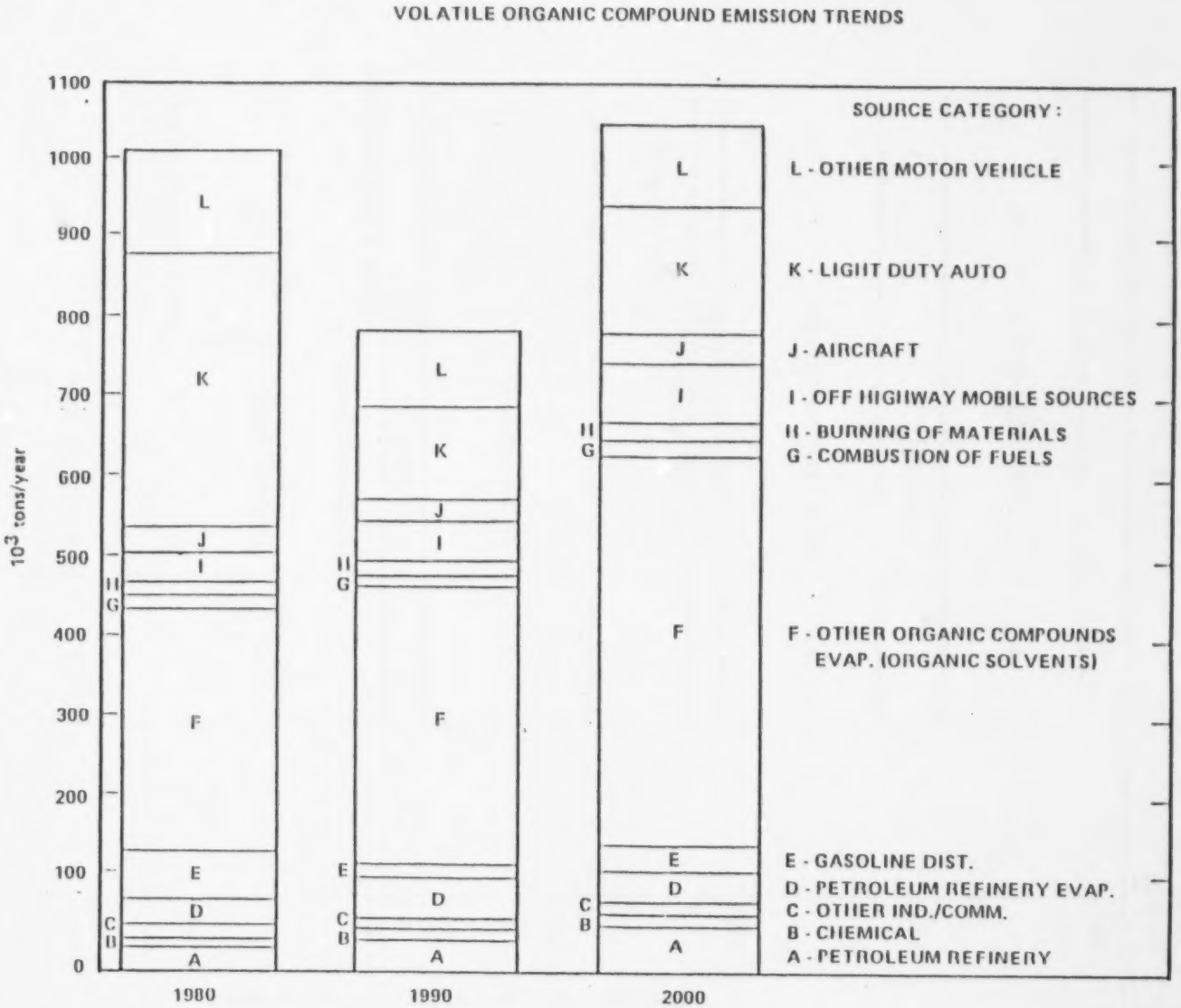
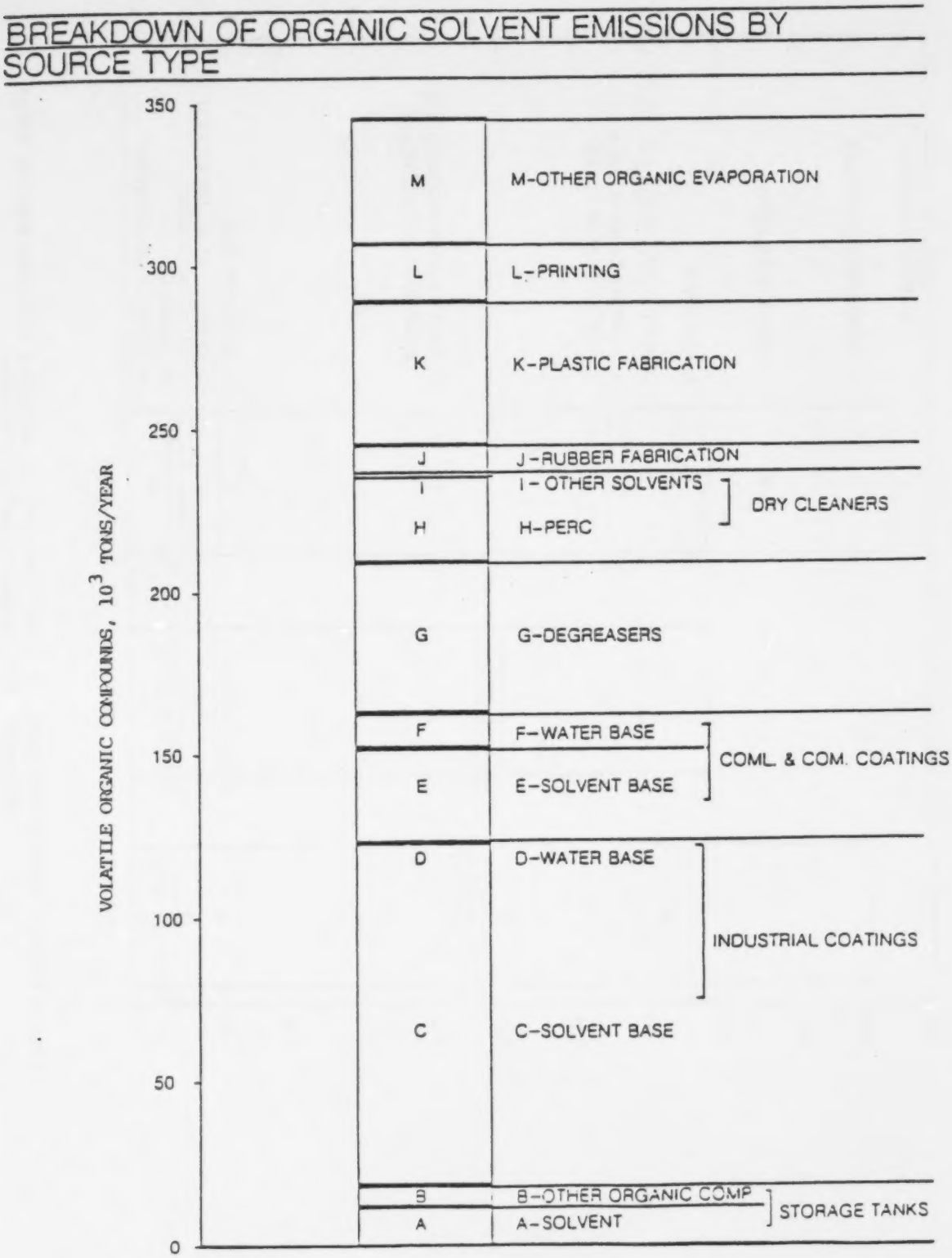


Figure 7.2-2. Example bar chart to illustrate source category contributions to total emissions and projected emission trends.

Figure 7.2-3. Breakdown of organic solvent emissions by source type.



and outside users (1) how the inventory was compiled and (2) how reliable the inventory is.

The following documentation items are suggested as information which will achieve these inventory goals.

A. Background information should be presented on reasons for compiling the inventory, its future uses, how it evolved, and the significance of changes from emissions of previous years. The source/receptor relationship used for ozone control strategy development should be specified.

B. The geographical area covered by the inventory should be specified. This may be a county, air basin, AQCR, etc. A map depicting the area should be included.

C. Population, employment, and economic data used in projections should be presented. These include data used in calculating emissions with per capita emissions and emissions-per-employee factors (see Item H).

D. The time interval represented by the emission inventory should be specified (e.g., annual, seasonal, hourly, etc.).

E. Traffic data for the inventory area should be summarized and presented. Documentation should include descriptions of procedures and models used in estimating the following: VMT, traffic speeds, miles of roadway for each roadway classification, hot and cold start percentages, hot soak and in transit emissions, average annual miles driven by vehicle model year, vehicle age distribution, traffic parameters for local (off network) traffic, traffic parameters for roadway outside of the transportation planning area but inside the inventory area, and any other parameters which significantly affect the highway vehicle emissions calculations.

F. Any proposed or promulgated control strategy programs that will affect the baseline inventory should be noted. In control strategy inventories, graphs and tables illustrating progress toward air quality goals should be included.

G. Baseline emission estimates should be summarized by source category in tabular format. These emission estimates should exclude nonreactive VOC.

1. Source categories for which the emissions are negligible should be listed as "Neg."

2. Source categories for which there are no emissions in the study area should be listed as "0."

H. A narrative should also be presented for each category of the inventory. The narrative should contain at least the following:

1. Procedures used to collect the data - Procedures should be presented which describe completely how the data were collected and

analyzed. A concise point source/area source definition should also be included.

2. Sources of the data - A complete description of the types of sources accessed in the course of compiling the inventory should be presented. These sources would include, for example, permit files, inspection reports, source test data, actual company inquiries, other agencies, etc. A statement should be included assessing the completeness of the data collected.

3. Copies of questionnaires - Samples of questionnaires mailed to various source categories for the collection of data should be included as part of the inventory documentation.

4. Questionnaire statistics - Statistics regarding the questionnaire should be presented. This information may include:

a. The number of questionnaires sent

b. The number for which response was received

c. The method of extrapolating available information for nonrespondents

d. Any assumptions made regarding the data received or not received.

5. Emission factor citation - Emission factors used for the calculation of emissions should be clearly stated. Factors from sources other than AP-42 may be used, but a rationale for the use of these other factors should be provided. Source test data are preferred over emission factors.

6. Method of calculation - Sample calculations for each type of computation should be presented, to allow for an independent verification of the computations. (Some emission factors are frequently misused.) Techniques for excluding nonreactive VOC from the inventory should be described.

7. Assumptions - Any assumptions made in any part of the procedures should be clearly stated.

8. Items not included - Any sources of emissions which are not included in the inventory should be itemized in the narrative. A statement as to why these sources were excluded should be presented. Possible reasons for exclusion could be:

a. The emissions from these sources are known to be negligible.

b. No emission factors exist, and no source test data are available to allow computation of these emissions.

c. Emissions from these sources have been taken into account by considering a background ozone concentration.

9. List of references - A list of references should be included as a final section of the narrative.

Additional items should be included in the inventory documentation if they will further clarify and support the inventory.

Once an inventory is well-documented and is technically sound, it can be useful for several years with only annual updating. In certain cases, adequate documentation may allow the agency to forego an update of certain portions of the inventory, so that more resources can be devoted to higher priority items in an ozone control program.

Technically correct and documented inventories are always in the best interest of all air pollution management agencies.

References for Chapter 7.0

1. AEROS Manual Series, Volume III: Summary and Retrieval, Second Edition, EPA-450/2-76-009a, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1977.

2. Emission Inventory Requirements for Post-1987 Ozone State Implementation Plans, EPA-450/4-88-019, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1988.

3. Example Emission Inventory Documentation for 1982 Ozone State Implementation Plans (SIPs), EPA-450/4-80-033, U.S. Environmental Protection Agency, Research Triangle Park, NC, March 1981.

APPENDIX A - GLOSSARY OF IMPORTANT TERMS

Activity level: Any variable parameter associated with the operation of a source (e.g., production rate, fuel consumption, etc.) that may be correlated with the air pollutant emissions from that source.

AP-42: EPA Document Number AP-42, Compilation of Air Pollutant Emission Factors, Environmental Protection Agency, Research Triangle Park, North Carolina. Supplements are published regularly. This document includes process descriptions and emission factors for a broad range of criteria pollutant emission sources.

Area source: Normally, an aggregation of all sources not defined as point sources in a specific geographic area. Area sources usually include all mobile sources and any stationary sources too small, difficult, or numerous to classify as point sources. The area source emissions are assumed to be spread over a broad area.

Baseline projection: Estimate of emissions expected in future years, based on a growth and emission control scenario. Baseline emission controls for a given projection year include only those controls that have been legally mandated at the time of preparing the projection.

Breathing loss: Loss of vapors from storage tanks due to diurnal warming and cooling.

Control strategy projection inventory: An inventory of emissions, for a future year, which differs from the baseline inventory in that it takes into account the expected impact of a proposed control strategy.

Correction factors: Special multipliers employed in emission calculations to adjust the resulting emission estimates more accurately by taking into account special parameters such as temperature, pressure, operating load, etc. Appropriate correction factors are particularly important in accurately calculating organic emissions from mobile sources and petroleum product storage and handling operations.

Degreasing: Any operation in which impurities such as greases and oils are removed from a surface using an organic solvent.

Diffusion modeling: A mathematical technique for calculating the atmospheric distribution of air pollutants based on emissions data and meteorological data for an area. Also referred to as dispersion modeling.

Documentation (inventory): A compilation of the methods, assumptions, calculations, references, etc., that are employed in the development of an inventory.

Dry cleaning: The practice of cleaning textile materials by treatment with organic solvents. The most common dry cleaning solvents are perchloroethylene and Stoddard.

Emission factor: An estimate of the rate at which a pollutant is released to the atmosphere as the result of some activity, divided by the rate of that activity (e.g., production rate or throughput).

Emission inventory: A compilation of information relating to sources of pollutant emissions, including location, quantity of emissions, number and type of control devices, stack dimensions and gas flow rates, and additional pertinent details.

Empirical Kinetic Modeling Approach (EKMA): A source/receptor relationship developed by EPA for estimating the overall reduction of volatile organic compound levels needed in an urban area based on existing oxidant levels and VOC/NOx ratios.

Evaporative losses: Emissions caused by the vaporization of materials (generally solvents) at normal atmospheric temperature and pressure conditions.

Exhaust gas: Any gas, along with any particulate matter and uncombined water contained therein, emitted from a source to the atmosphere.

Fugitive organics: Organic compounds that are not emitted from a source through stacks, vents, or other confined air streams.

Gasoline marketing operations: The operations and systems associated with the transportation of gasoline from refineries to bulk terminals, to bulk storage, to dispensing outlets, and to vehicle gas tanks.

Gridding and subcounty allocation: The practice of distributing emissions or any other parameter from a larger geographical area (usually a county) to a smaller geographic area (i.e., a grid) using data presumed to be proportional to the parameter being distributed.

Hydrocarbons: Any compounds containing only carbon and hydrogen. The term "hydrocarbon" is often used synonymously with "volatile organic compound," although the latter also includes hydrocarbon derivatives, as well.

Imprecision (emission inventory): That error in an emission inventory due to the variability (or random error) in the data used in determining the inventory.

Inaccuracy (emission inventory): That error in an emission inventory due to omissions, errors, and biases in the data used in determining the inventory.

Inventory: A compilation of source, control device, emissions, and other information relating to sources of a pollutant or group of pollutants.

Land use projection: Estimate of land use in a future year (often given in terms of land use maps representing the projected conditions).

Material balance: Technique used to estimate emissions from a source by accounting for the weights of one or more substances in all incoming and outgoing process streams.

Methane: The simplest hydrocarbon species; often excluded from VOC measurements or inventories because it is essentially unreactive in atmospheric photochemical reactions.

Mobile source: Any moving source of air pollutants, such as automobiles, vessels, locomotives, aircraft, etc.

Motor vehicles: Motor powered vehicles such as automobiles, trucks, motorcycles, and buses, operated primarily on streets and highways.

National Emission Data System (NEDS): An automatic data processing system developed by EPA for storage and retrieval of source and emission data.

Nitric oxide (or nitrogen oxide): One of the two oxides of nitrogen which are collectively referred to as NO_x (q.v.). The amount of nitric oxide (NO) in NO_x is often reported in terms of the equivalent weight of nitrogen dioxide (NO_2), in which case its true weight is only 30/46 of the reported weight.

Nitrogen dioxide: One of the two oxides of nitrogen which are collectively referred to as NO_x (q.v.). The total weight of NOx is often reported "as nitrogen dioxide (NO_2)", which is not the true weight of the mixture but the weight which would be attained if all the nitric oxide (NO) were converted to NO_2.

Nonmethane: Excluding methane (CH_4).

Nonmethane hydrocarbon: All hydrocarbons, or all VOC, except methane.

Office of Business Economics, Research Service (OBERS): Acronym used in reference to projections prepared jointly by the U.S. Department of Commerce, Bureau of Economic Affairs, Office of Business Economics, and the U.S. Department of Agriculture, Economic Research Service, for the U.S. Water Resources Council, April 1974.

Oxides of nitrogen: In air pollution usage, this comprises nitric oxide (NO) and nitrogen dioxide (NO_2); usually expressed in terms of the equivalent amount of NO_2.

Ozone: Three atoms of oxygen (O_3) combined through complex photochemical reactions involving volatile organic compounds and oxides of nitrogen; the principal chemical component of the photochemical oxidant formed in photochemical air pollution.

Ozone control strategy: A plan developed by an agency to control ambient ozone levels within its jurisdiction.

Ozone precursors: Volatile organic compounds and oxides of nitrogen, as air pollutant emissions and as air contaminants which undergo a series of reactions under the influence of ultraviolet light from the sun, to form photochemical oxidants, including ozone.

Ozone season: That period of the year during which conditions for photochemical ozone formation are most favorable. Generally, sustained periods of direct sunlight (i.e., long days, small cloud cover) and warm temperatures.

Paraffins: Saturated, nonaromatic hydrogen compounds, also known as long-chain alkanes.

Photochemistry: The chemistry of reactions which involve light as the source of activation energy.

Photochemical model (air quality): A detailed computer model that estimates ozone concentrations both as a function of space and time by directly simulating all of the physical and chemical processes that occur during the photochemical process.

Point source: Generally, any stationary source for which individual records are collected and maintained. Point sources are usually defined as any facility which releases more than a specified amount of a pollutant.

Process variable: Any condition associated with the operation of a process, including the quantities and properties of any materials entering or leaving any point in the process, which is, or may readily be, monitored, measured, etc., during the normal course of process operation.

Process weight rate: The process weight charged per unit of time. The term is loosely used interchangeably with operating rate. However, operating rate may cover either input to or output from a process, whereas strictly speaking, process weight rate should cover only material input to a process.

Reactivity: A measure of the rate and extent to which a volatile organic compound will react, in the presence of sunlight and nitrogen oxides, to form photochemical ozone.

RACT (Reasonably Available Control Technology): Reasonably available control technology is defined as the lowest emission limit that a particular source is capable of meeting by the application of control technology that is reasonably available considering technical and economic feasibility.

Rule effectiveness: A measure of the ability of the regulatory program to achieve all the emission reductions that could be achieved by full

compliance with the applicable regulations at all sources at all times. It reflects the assumption that regulations typically are not 100 percent effectiveness due to limitations of control techniques or shortcomings in the enforcement process.

Rule penetration: With regard to penetration into the inventory, it is the portion (in percent) of the area source category that is covered by the regulation.

Seasonal adjustment: Used with reference to annual average rates of pollutant emissions, this is the factor needed to calculate daily or hourly average rates for one season (in the case of ozone, summer rates are most commonly required).

SIC Codes (Standard Industrial Classification Codes): A series of codes devised by the Office of Management and Budget to classify establishments according to the type of economic activity in which they are engaged.

SIP (State Implementation Plan) inventories: Emission inventories required as part of the overall State Implementation Plan for achieving the National Ambient Air Quality Standards. States are required under the Clean Air Act to submit these plans to the U.S. Environmental Protection Agency.

Solvent: Any organic compound, generally liquid, that is used to dissolve another compound or group of compounds.

Source: Any person, device, or property that contributes to air pollution.

Source category: Any group of similar sources. For instance, all residential dwelling units would constitute a source category.

Source (process) information: Information collected on each point source in an inventory that describes that source, such as location, fuel use and fuel characteristics, operational data, stack data, or other identifiers. Source information, together with emissions and control device data, comprise the basic elements of an emission inventory. For area sources, this information is usually limited to activity levels.

Source/receptor model: A model or relationship that predicts ambient ozone levels based on precursor emission strengths (of NO_x and VOC) and various meteorological parameters. Source/receptor models may range in complexity from simple empirical or statistical relationships (such as rollback or the Empirical Kinetic Modeling Approach [EKMA]) to detailed photochemical atmospheric simulation models.

Source test: Direct measurement of pollutants in the exhaust stream(s) of a facility.

Spatial resolution: The degree to which the location of a source can be pinpointed geographically within an inventory area.

Species: With regard to VOC, a specific chemical which is part of a particular volatile organic compound, such as methane, 2-hexane, 1,1,1-trichloroethane, etc. With regard to NO_x, a species is either nitric oxide (NO) or nitrogen oxide (NO_2).

Species class: Any grouping of VOC compounds, combined in accordance with regulatory policy or rules specified by input instructions for a photochemical simulation model. Also called "reactive class" or "reactivity class".

Stack parameters: Parameters characteristic of a stack and stack gases, as required far input to some models. Typically included are stack height, inner diameter, volume flow rate, and temperature of gas, all of which are needed to calculate effective stack height (i.e., stack height plus plume rise).

Stationary source: A source which remains at a fixed location while emitting pollutants. Generally, any nonmobile source of air pollutants.

Surface coating: Operations involving the application of paints, varnishes, lacquers, inks, fabric coatings, adhesives, and other coating materials. Emissions of organic compounds result when the volatile portion of the coating evaporates.

Surrogate indicator: (1) For spatial resolution, a quantity for which distribution over an area is known or accurately estimated and which may be assumed similar to the emissions distribution from some source category for which spatial allocation is unknown. (2) For growth, a quantity for which official growth projections are available which may be assumed similar to that of activity in some source category for which projections are needed.

Temporal resolution: (1) The process of determining or estimating what emissions may be associated with various seasons of the year, days of the week, or hours of the day, given annual totals or averages. (2) A measure of the smallest time interval with which emissions can be associated in an inventory.

Transportation planning model: A system of computer programs which are used in simulating the performance of existing and future transportation systems in an urban area.

Urban Transportation Planning System: An urban transportation planning battery of computer programs distributed jointly by the Urban Mass Transit Administration, and the Federal Highway Administration.

Vehicle miles traveled: An estimated total of number of miles traveled by all vehicles, or by all vehicles of a given category, in a specified region for a specified period of time; often used as a surrogate indicator for spatial resolution of motor vehicle emissions.

Vehicle mix: Composition of vehicular traffic as determined by the fraction of vehicle miles traveled by each class of vehicle.

Volatile organic compounds (VOC): Organic compounds include all compounds of carbon except carbonates, metallic carbides, carbon monoxide, carbon dioxide, and carbonic acid. A volatile organic compound (VOC) is any organic compound that, when released to the atmosphere, can remain long enough to participate in photochemical reactions. While there is no clear line of demarcation between volatile and nonvolatile organics, the predominant fraction of the VOC burden is made up of compounds which evaporate rapidly at ambient temperatures.

Volume percent: The number of volumes of a given component in 100 volumes of a mixture. In gaseous mixtures, equivalent to mole percent.

Weight percent: The number of weight or mass units of a given component in 100 units of a mixture.

Zone: A subdivision of a study area, constituting the smallest geographic area for which data are aggregated and basic analyses made.

APPENDIX B - POINT SOURCE PROCESS EMISSION REPORTING FORMAT

EPA proposed that post-1987 ozone SIP emission inventories be reported in the formats shown in Figures B-1 and B-2 of this Appendix.[1] In addition to presenting a summary of point and area source emissions in the format of Figure B-1, point source emissions for each facility are to be reported by process as shown in Figure B-2.

While these reporting tables are not required for all inventories, use of some type of point source data sheet is recommended. By identifying emissions at the process level, the effect of various control strategies can be better predicted.

Reference for Appendix B

1. Emission Inventory Requirements for Post-1987 Ozone State Implementation Plans, EPA-450/4-88-019, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1988.

TABLE B-1. INDIVIDUAL SOURCE SUMMARY[a]

STORAGE, TRANSPORTATION AND MARKETING OF PETROLEUM PRODUCTS AND VOLATILE ORGANIC LIQUIDS

1. Oil and Gas Production
   - Detailed emissions from well head to load-out, including process sources, storage, fugitive and handling

2. Petroleum Product and Crude Oil Storage
   - Fixed Roof Tanks
   - External Floating Roof Tanks
     - Primary Seals
     - Secondary Seals
   - Internal Floating Roof Tanks
   - Leaks from Valves, Flanges Meters, Pumps

3. Bulk Terminals
   - Fixed Roof Tanks
   - External Floating Roof Tanks
     - Primary Seals
     - Secondary Seals
   - Internal Floating Roof Tanks
   - Leaks from Valves, Flanges Meters, Pumps
   - Vapor Collection Losses
   - Filling Losses from Uncontrolled Loading Racks
   - Tank Truck Vapor Leaks from Loading of Gasoline
   - Non-Tank Farm Storage

4. Bulk Plants
   - Fixed Roof Tanks
   - External Floating Roof Tanks
     - Primary Seals
     - Secondary Seals
   - Internal Floating Roof Tanks
   - Loading and Unloading Racks
   - Tank Truck Vapor Leaks
   - Leaks from Valves, Flanges Meters, Pumps

5. Volatile Organic Liquid Storage and Transfer
   - Fixed Roof Tanks
   - External Floating Roof Tanks
     - Primary Seals
     - Secondary Seals
   - Internal Floating Roof Tanks
   - Loading and Unloading Racks
   - Tank Truck Vapor Leaks
   - Leaks from Valves, Flanges Meters, Pumps

TABLE B-1. INDIVIDUAL SOURCE SUMMARY (Continued)

STORAGE, TRANSPORTATION AND MARKETING OF PETROLEUM PRODUCTS AND VOLATILE ORGANIC LIQUIDS (Continued)

6. Vessels
   - Petroleum Products and VOL Loading - Barge
   - Petroleum Products and VOL Loading - Tanker
   - Crude Oil Ballasting - Tanker

7. Barge, Tanker, Tank Truck and Rail Car Cleaning

8. Barges, Tankers, Tank Trucks and Rail Cars in Transit

9. Service Station Loading (Stage I)

10. Service Station Loading (Stage II)

11. Formulation and Packing VOL for Market

12. Local Storage (airports, industries that use fuels, solvents and reactants in their operation).

INDUSTRIAL PROCESSES

1. Petroleum Refineries
   - Process Drains ans Wastewater Separators
   - Vacuum Producing Systems
   - Process Unit Turnarounds
   - Fugitive Leaks from Seals, Valves, Flanges, Pressure Relief Devices and Drains
   - Petroleum Coking
   - Cooling Towers
   - Secondary Losses (Wastewater - Solid Waste)
   - Other Process Emissions such as Heaters, Boilers, Catalytic Cracker Regenerators (specify)

2. Natural Gas and Petroleum Product Processing

3. Lube Oil Manufacture

4. Organic Chemical Manufacture
   - Fugitive Leaks from Seals, Valves, Flanges, Pressure Relief Devices and Drains
   - Air Oxidation Units
   - Storage and Transfer
   - Wastewater Separators
   - Handling
   - Secondary Losses (Wastewater - Solid Waste)
   - Other Process Units (specify)

TABLE B-1. INDIVIDUAL SOURCE SUMMARY (Continued)

INDUSTRIAL PROCESSES (Continued)

5. Inorganic Chemical Manufacture
   - Fugitive Leaks from Seals, Valves, Flanges, Pressure Relief Devices and Drains
   - Storage and Transfer
   - Clean Up
   - Secondary Losses (Wastewater - Solid Waste)
   - Other Process Units (specify)

6. Iron & Steel Production
   - Sintering
   - Electric Arc Furnaces
   - Other Process Units (specify)
   - Secondary Losses (Wastewater - Solid Waste)

7. Coke Production
   - Coke Pushing
   - Coke Oven Doors
   - Coke Charging
   - Coke Preheater
   - Topside Leaks
   - Quenching
   - Battery Stacks
   - Secondary Losses (Wastewater - Solid Waste)

8. Coke By-Product Plants
   - Collection Leaks
   - Primary Cooler
   - Ammonia Stills
   - Light Oil Scrubbers
   - Tar Precipitators
   - BTX Stills
   - Tar Decanters
   - Secondary Losses (Wastewater - Solid Waste)
   - Other Unit Operations (specify)

9. Synthetic Fiber Manufacture
   - Dope Preparation
   - Filtration
   - Fiber Extrusion - Solvent Recovery
   - Takeup Stretching, Washing, Drying, Crimping, Finishing
   - Fiber Storage - Residual Solvent Evaporation
   - Equipment Leakage
   - Solvent Storage
   - Secondary Losses (Wastewater - Solid Waste)
   - Other Process Units (specify)

TABLE B-1. INDIVIDUAL SOURCE SUMMARY (Continued)

INDUSTRIAL PROCESSES (Continued)

10. Polymers and Resins Manufacture
    - Catalyst Preparation
    - Reactor Vents
    - Separation of Reactants, Solvents, Diluents from Product
    - Raw Material Storage
    - Solvent Storage
    - Handling
    - Equipment Leakage
    - Secondary Losses (Wastewater - Solid Waste)
    - Other Process Units (specify)

11. Plastic Products Manufacture
    - Mold Release
    - Solvent Consumption
    - Adhesive Consumption
    - Adhesives Preparation
    - Fiber Storage - Residual Solvent Evaporation
    - Secondary Losses (Wastewater - Solid Waste)
    - Other Process Units (specify)

12. Fermentation Processes
    - Fermentation Tank Venting
    - Aging (Wine or Whiskey)
    - Drying/Conditioning Used Grain
    - Bottling
    - Clean Up
    - Secondary Losses (Wastewater - Solid Waste)
    - Other Process Units (specify)

13. Vegitable Oil Processing
    - Oil Extraction and Desolventation
    - Meal Preparation
    - Oil Refining
    - Fugitive Leaks
    - Solvent Storage
    - Secondary Losses (Wastewater - Solid Waste)
    - Other Process Units (specify)

14. Pharmaceutical Manufacturing
    - Process Units such as Vacuum Dryers, Reactors, Distillation Units, Filters, Extractors, Centrifuges, Crystallizers
    - Major Production Equipment such as Exhaust Systems and Air Dryers
    - Storage and Transfer
    - Fugitive Leaks
    - Packaging
    - Secondary Losses (Wastewater - Solid Waste)
    - Other Process Units (specify)

TABLE B-1. INDIVIDUAL SOURCE SUMMARY (Continued)

INDUSTRIAL PROCESSES (Continued)

15. Rubber Tire Manufacture
    - Undertread and Sidewall Cementing
    - Bead Dipping
    - Bead Swabbing
    - Tire Building
    - Tread End Cementing
    - Green Tire Spraying
    - Tire Curing
    - Solvent Mixing
    - Solvent Storage
    - Retreaders
    - Secondary Losses (Wastewater - Solid Waste)
    - Other Process Units (specify)

16. SBR Rubber Manufacture
    - Blowdown Tanks
    - Steam Stripper
    - Prestorage Tanks
    - Secondary Losses (Wastewater - Solid Waste)
    - Other Process Units (specify)

17. Ammonia Production
    - Desulfurization Unit Generation
    - Primary Reformer, Heater Fuel Combustion
    - Carbon Dioxide Regenerator
    - Condensate Steam Stripper

18. Carbon Black Manufacture
    - Main Process Vent
    - Flare
    - CO Boiler
    - Solid Waste Generator

19. Phthalic Anhydride Production
    - Oxidation of o-Xylene
      - Main Process Stream
      - Pretreatment
      - Distillation
    - Oxidation of Naphthalene
      - Main Process Stream
      - Pretreatment
      - Distillation

TABLE B-1. INDIVIDUAL SOURCE SUMMARY (Continued)

INDUSTRIAL PROCESSES (Continued)

20. Terephthalic Acid Production
    - Reactor Vent
    - Crystallization, Separation, Drying
    - Distillation and Recovery
    - Product Transfer

21. Maleic Anhydride Production
    - Storage
    - Fugitive Leaks
    - Other Process Units (specify)

22. Pulp and Paper Mills

23. Primary and Secondary Metals Production

24. Plywood, Particle Board, Pulp Board, Chip or Flake Wood Board

25. Charcoal Production

26. Carbon Electrode and Graphite Production

27. Paint, Varnish and Other Coatings Production

28. Adhesives Production

29. Printing Ink Manufacture

30. Scrap Metals Clean Up

31. Adipic Acid Proction

32. Coffee Roasting

33. Grain Elevators (fumigation)

34. Meat Smokehouses

35. Asphalt Roofing Manufacture

36. Bakeries

37. Fabric, Thread and Fiber Dying and Finishing

38. Glass Fiber Manufacture

39. Glass Manufacture

TABLE B-1. INDIVIDUAL SOURCE SUMMARY (Continued)

INDUSTRIAL PROCESSES (Continued)

40. Soaps, Detergents and Cleaning Agents Manufacturing, Formulation and Packaging

41. Food and Animal Feedstuff Processing and Preparation

42. Bricks and Related Clays

INDUSTRIAL SURFACE COATING

1. Large Appliances
   - Cleaning and Pretreatment
   - Prime Spray, Flow or Dip Coating Operations
   - Topcoat Spray
   - Coating Mixing
   - Coating and Solvent Storage
   - Equipment Clean Up
   - Other Process Units (specify)

2. Magnet Wire
   - Cleaning and Pretreatment
   - Coating Applications and Curing
   - Coating Mixing
   - Coating and Solvent Storage
   - Equipment Clean Up
   - Other Process Units (specify)

3. Autos and Light Trucks
   - Cleaning and Pretreatment
   - Prime Application, Electrodeposition, Dip or Spray
   - Prime Surface Operations
   - Topcoat Operation
   - Repair Topcoat Application Area
   - Coating Mixing
   - Coating and Solvent Storage
   - Equipment Clean Up
   - Other Process Units (specify)

4. Cans
   - Cleaning and Pretreatment
   - Two Piece and Exterior Base Coating
   - Interior Spray Coating
   - Sheet Basecoating (Interior)
   - Sheet Basecoating (Exterior)
   - Side Seam Spray Coating
   - End Sealing Compound
   - Lithography
   - Overvarnish
   - Coating Mixing
   - Coating and Solvent Storage
   - Equipment Clean Up

TABLE B-1. INDIVIDUAL SOURCE SUMMARY (Continued)

INDUSTRIAL SURFACE COATING (Continued)

5. Metal Coils
   - Prime Coating
   - Finish Coating
   - Coating Mixing
   - Coating and Solvent Storage
   - Equipment Clean Up
   - Other Process Units (specify)

6. Paper/Fabric
   - Coating Operations
   - Coating Mixing
   - Coating and Solvent Storage
   - Equipment Clean Up
   - Other Process Units (specify)

7. Wood Furniture
   - Coating Operations
   - Coating Mixing
   - Coating and Solvent Storage
   - Equipment Clean Up
   - Other Process Units (specify)

8. Metal Furniture
   - Cleaning and Pretreatment
   - Coating Operations
   - Coating Mixing
   - Coating and Solvent Storage
   - Equipment Clean Up
   - Other Process Units (specify)

9. Miscellaneous Metal Parts and Products
   - Cleaning and Pretreatment
   - Coating Operations, Flow, Dip, Spray
   - Coating Mixing
   - Coating and Solvent Storage
   - Equipment Clean Up
   - Other Process Units (specify)

10. Flatwood Products
    - Filler
    - Sealer
    - Basecoat
    - Topcoat
    - Inks
    - Coating Mixing
    - Coating and Solvent Storage
    - Equipment Clean Up
    - Other Process Units (specify)

TABLE B-1. INDIVIDUAL SOURCE SUMMARY (Continued)

INDUSTRIAL SURFACE COATING (Continued)

11. Plastic Products
    - Cleaning and Pretreatment
    - Coating Operations, Flow, Dip, Spray
    - Coating Mixing
    - Coating and Solvent Storage
    - Equipment Clean Up
    - Other Process Units (specify)

12. Large Ships
    - Cleaning and Pretreatment
    - Prime Coat Operation
    - Top Coat Operation
    - Coating Mixing
    - Coating and Solvent Storage
    - Equipment Clean Up
    - Other Process Units (specify)

13. Large Aircraft
    - Cleaning and Pretreatment
    - Prime Coat Operation
    - Top Coat Operation
    - Coating Mixing
    - Coating and Solvent Storage
    - Equipment Clean Up
    - Other Process Units (specify)

NONINDUSTRIAL SURFACE COATING

1. Architectural Coatings

2. Auto Refinishing

OTHER SOLVENT USE

1. Degreasing
    - Cold cleaning
    - Vapor Degreasing
    - Conveyorized Degreasing

2. Dry Cleaning
    - Perchloroethylene
    - Petroleum Solvents

TABLE B-1. INDIVIDUAL SOURCE SUMMARY (Continued)

OTHER SOLVENT USE (Continued)

3. Graphic Arts
   - Letterpress
   - Rotogravure
   - Offset Lithography
   - Ink Mixing
   - Solvent Storage
   - Flexography
   - Equipment Clean Up

4. Adhesives
   - Adhesive Application
   - Solvent Mixing
   - Solvent Storage
   - Packaging
   - Equipment Clean Up
   - Other Process Units (specify)

5. Solvent Extraction Processes

6. Cutback Asphalt

7. Consumer/Commercial Solvent Use
   - Paints, Primers, Varnishes
   - Hair Sprays
   - All Purpose Cleaners
   - Insect Sprays
   - Car Polishes and Waxes
   - Room Deodorants and Disinfectants
   - Window and Glass Cleaners
   - Caulking and Sealing Compounds
   - Moth Control Products
   - Herbicides, Fungicides
   - Carburetor and Choke Cleaners
   - Auto Antifreeze
   - Personal Deodorants
   - Brake Cleaners
   - Adhesives (Consumer)
   - Engine Starting Fluids
   - Lubricants and Silicones
   - Engine Degreasers
   - Metal Cleaners and Polishes
   - Rug and Upholstery Cleaners

8. Asphalt Roofing Kettles

9. Pesticide Application

TABLE B-1. INDIVIDUAL SOURCE SUMMARY (Continued)

EXTERNAL COMBUSTION SOURCES

1. Industrial Fuel Combustion

2. Coal Cleaning
   - Fluidized Bed
   - Flash
   - Multilouvered

3. Electrical Generation

4. Commercial/Institutional Fuel Combustion

5. Residential Fuel Combustion

6. Resource Recovery Facilities

7. Solid Waste Disposal
   - On-Site Incineration
   - Open Burning
   - Prescribed Burning
   - Structural Fires
   - Wildfires

8. Recycle/Recovery (Primary Metals)
   - Auto Body Incineration
   - Drum Cleaning

9. Sewage Sludge Incinerators

STATIONARY INTERNAL COMBUSTION

1. Reciprocation Engines

2. Gas Turbines

WASTE DISPOSAL

1. Publicly Owned Treatment Works

2. Industrial Wastewater Treatment

3. Municipal Landfills

TABLE B-1. INDIVIDUAL SOURCE SUMMARY (Continued)

WASTE DISPOSAL (Continued)

4. Hazardous Waste Treatment, Storage and Disposal Facilities
   - Landills
   - Landfarms
   - Surface Impoundments
   - Storage
   - Incinerators
   - Leaking Undergroud Storage Tanks
   - Wastepiles

MOBILE SOURCES

1. Highway Vehicles
   - Light Duty Autos
   - Light Duty Trucks
   - Heavy Duty Autos
   - Heavy Duty Gasoline Trucks
   - Heavy Duty Diesel Trucks
   - Motorcycles

2. NonHighway Vehicles
   - Railroad Locomotives
   - Aircraft
     - Military
     - Civil
     - Commercial
   - Vessels
   - Motorboats
   - Off-Highway Motorcycles
   - Construction Equipment
   - Industrial Equipment
   - Farm Equipment
   - Lawn and Garden Equipment
   - Snowmobiles
   - Orchard Heaters

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[a] Pollutants in each source category are shown in Table 2.2-1.

Figure B-1

Summary Table Of VOC Emissions For _____
(County or Equivalent)

(tons per day)[1]

	Applicable Regulation[2]	Base Year (specify year)		Base Line Projection (specify year)		Revised SIP Strategy Projection (specify year)	
		Point	Area	Point	Area	Point	Area
orage, Transportation d Marketing Of VOC							
l and Gas Production							
tural Gas and Gasoline Processing							
ner Petroleum Processing							
soline and Crude Oil Storage[3]							
All (except floating roof)							
Floating Roof							
latile Organic Liquid Storage							
L - Transfer							
Ship and Barge							
Other							
rge and Tanker Cleaning							
lk Gasoline Terminals[4]							
soline Bulk Plants[5]							
rvice Station Loading (Stage I)							
rvice Station Unloading (Stage II)							
soline Tank Trucks							
ners (specify)							
dustrial Processes							
troleum Refineries							
Vacuum Systems							
Fugitive							
Other							
be Oil Manufacture							

pical ozone season weekday
ist apprevations at end of table with brief explanation,
i.e., I = Group I CTGs - State Reg XX.X;
I = Group II CTGs - State Reg. YY.Y, etc.)
ncludes all storage facilities except those at service stations and bulk plants
nissions from loading tank trucks and rail cars
nissions from storage and transfer operations

Figure B-1 (cont)

Summary Table Of VOC Emissions For _____
(County or Equivalent)

(tons per day)[1]

	Applicable Regulation[2]	Base Year (specify year)		Base Line Projection (specify year)		Revised SIP Strategy Projection (specify year)	
		Point	Area	Point	Area	Point	Area
Organic Chemical Manufacture							
Polyethylene							
Propylene							
Styrene							
Others (specify)							
SOCMI							
Fugitive							
Air Oxidation							
Others (specify)							
Inorganic Chemical Manufacture							
Fermentation Processes							
Vegetable Oil Processing							
Pharmaceutical Manufacture							
Plastic Products Manufacture							
Rubber Tire Manufacture							
SBR Rubber Manufacture							
Textile Polymers and Resin Manufacture							
Synthetic Fiber Manufacture							
Iron and Steel Manufacture							
Coke Ovens							
Others (specify)							
Industrial Surface Coating							
Large Appliances							
Magnet Wire							
Autos and Light Trucks							
Cans							
Metal Coils							
Paper							
Fabric							
Metal and Wood Furniture							
Miscellaneous Metal Products							
Flatwood Products							
Plastic Products							
(continued on next page)							

[1] Typical ozone season weekday
[2] List appreviations at end of table with brief explanation, (i.e., I = Group I CTGs - State Reg XX.X; II = Group II CTGs - State Reg. YY.Y, etc.).

Figure B-1 (Cont)

Summary Table Of VOC Emissions For _____
(County or Equivalent)

(tons per day)[1]

	Applicable Regulation[2]	Base Year (specify year)		Base Line Projection (specify year)		Revised SIP Strategy Projection (specify year)	
		Point	Area	Point	Area	Point	Area
ge Ships							
ge Aircraft							
ers (specify)							
-industrial Surface Coating							
hitectural Coatings							
ɔ Refinishing							
ers (specify)							
er Solvent Use							
reasing							
Cleaning							
erchloroethylene							
etroleum							
cher							
ɔhic Arts							
esives							
ɔack Asphalt							
vent Extraction Processes							
sumer/Commercial Solvent Use							
ers (specify)							
ce Disposal							
icipal Waste							
ɔmbustion							
andfills							
s							
ls							
s							
ustrial Boiler Co-firing							
ers (specify)							

pical ozone season weekday
ist appreviations at end of table with brief explanation,
i.e., I = Group I CTGs - State Reg XX.X;
I = Group II CTGs - State Reg. YY.Y, etc.).

Figure B-1 (cont)

Summary Table Of VOC Emissions For _____
(County or Equivalent)

(tons per day)[1]

	Applicable Regulation[2]	Base Year (specify year)		Base Line Projection (specify year)		Revised SIP Strategy Projection (specify year)	
		Point	Area	Point	Area	Point	Area
Other Miscellaneous Sources							
Fuel Combustion							
Forest, Agricultural, and Other Open Burning							
Pesticide Applications							
Stationary Internal Combustion Engines							
Mobile Sources							
Highway Vehicles							
Light Duty Autos							
Light Duty Trucks							
Heavy Duty Gasoline Trucks							
Heavy Duty Diesel Trucks							
Other Highway Vehicles							
Non-highway Vehicles							
Rail							
Aircraft							
Vessels							
Other							
Mobile Sources Total:							
Stationary Sources Total:							
Grand Total For All Sources:							

1 Typical ozone season weekday
2 List appreviations at end of table with brief explanation, (i.e., I = Group I CTGs - State Reg XX.X; II = Group II CTGs - State Reg. YY.Y, etc.).

Figure B-1 (cont)

Summary Table For Oxides Of Nitrogen Emissions For _____
(County or Equivalent)

(tons per day)[1]

	Base Year		Base Line Projection		Revised SIP Strategy Projection	
	Point	Area	Point	Area	Point	Area
ernal Fuel Combustion						
tility Boilers						
ıdustrial Boilers						
ɔmmercial, Institutional, Residential						
ther External Fuel Combustion						
tionary Internal Combustion						
eciprocating Engines						
as Turbines						
er Combustion						
ıste Disposal						
ɔen Burning						
ther						
ıstrial Processes						
ıemical Manufacturing						
Adipic Acid						
Nitric Acid						
Other						
ron and Steel						
neral Products						
Cement						
Glass						
Other						
etroleum Refining						
ther						
le Sources						
ghway Vehicles						
Light Duty Autos						
Light Duty Trucks						
Heavy Duty Gasoline Trucks						
Heavy Duty Diesel Trucks						
Other Highway Vehicles						

ical ozone season weekday

Figure B-1 (cont)

Summary Table For Oxides Of Nitrogen Emissions For _____
(County or Equivalent)

(tons per day)[1]

	Base Year		Base Line Projection		Revised SIP Strategy Projection	
	Point	Area	Point	Area	Point	Area
Non-highway Vehicles						
Rail						
Aircraft						
Vessels						
Other						
Mobile Sources Total:						
Stationary Sources:						
>250m Effective Stack Height: Subtotal						
Other Stationary Sources: Subtotal						
Grand Total For All Sources:						

[1] Typical ozone season weekday

Figure B-1 (cont)

Summary Table For Carbon Monoxide Emissions For _____
(County or Equivalent)

(tons per day)[1]

	Base Year		Base Line Projection		Revised SIP Strategy Projection	
	Point	Area	Point	Area	Point	Area
ernal Fuel Combustion						
tility Boilers						
ndustrial Boilers						
ommercial, Institutional, Residential						
ther External Fuel Combustion						
tionary Internal Combustion						
eciprocating Engines						
as Turbines						
er Combustion						
aste Disposal						
ther						
ustrial Processes						
hemical Manufacturing						
ron and Steel						
ineral Products						
etroleum Refining						
ther						
ile Sources						
ighway Vehicles						
Light Duty Autos						
Light Duty Trucks						
Heavy Duty Gasoline Trucks						
Heavy Duty Diesel Trucks						
Other Highway Vehicles						
on-highway Vehicles						
Rail						
Aircraft						
Vessels						
Other						

ical ozone season weekday

Figure B-1 (cont)

Summary Table For Carbon Monoxide Emissions For _____
(County or Equivalent

(tons per day)[1]

	Base Year		Base Line Projection		Revised SIP Strategy Projection	
	Point	Area	Point	Area	Point	Area
Mobile Sources Total:						
Stationary Sources:						
>250m Effective Stack Height: Subtotal						
Other Stationary Sources: Subtotal						
Grand Total For All Sources:						

Typical ozone season weekday

Data Elements

I. PLANT INFORMATION

* NEDS State ID
* NEDS County ID
* NEDS Plant ID
* NEDS Pollutant
* Model Area (County, Township, or Grid Cell)
  Number of Employees
* Base Year of Inventory
  UTM Zone
  UTM Coordinates (km)
    X:
    Y:
* Plant Name
* Street Address
* City
* State
* Zip Code
  Plant Contact
* Plant SIC Code(s)
  Principal Product
  Projected Attainment Year
  Total Plant Banked Emissions
  Year Emissions Banked

II. POINT INFORMATION

* NEDS Point ID
* Point Description
  % Annual Throughput
    Dec-Feb
    Mar-May
    June-Aug
    Sept-Nov
  Normal Operation Schedule
* hrs/day
* days/wk
* wks/yr
  daily start/end times
* Regulation in Place? (Y/N)
* Emission Limitation
* Compliance Year
* CTG Category (I,II,III)

Data Elements (continued)

III. SEGMENT INFORMATION

* SCC
* SCC Description
* Process Rate Units

A. BASE YEAR INFORMATION

  Actual Annual Process Rate
  Seasonal Adjustment Factor
* O3 Season Daily Process Rate
  Maximum Hourly Design Rate
  Control Equipment
* primary
* secondary
* Control Efficiency (%)
* Emission Estimation Method
* Emission Factor Units
* Emission Factor (uncontrolled emissions)
  Annual Base Year Emissions (tons/yr)
* Rule Effectiveness (%)
* O3 Season Daily Emissions (lbs/day)
  Banked Emissions (tons/yr)
  Comment

B. PROJECTED YEAR INFORMATION

  Projected Baseline Information
    Compliance Year
    Control Equipment
      primary
      secondary
    Control Efficiency (%)
    Growth Factor
    Baseline Daily Emissions (lbs/day)
  Projected Control Strategy Info
    Regulation in Place? (Y/N)
    Emission Limitation
    Compliance Year
    Control Equipment
      primary
      secondary
    Control Efficiency (%)
    Rule Effectiveness (%)
    SIP Strategy Daily Emissions (lbs/day)

* Required for base year ozone or CO SIP emission inventory.

Figure B-2. Ozone SIP emission inventory point source information.

APPENDIX C - SUMMARY OF CONTROL TECHNIQUES GUIDELINES

C-1 BACKGROUND

The Clean Air Act Amendments of 1977 require each state having a nonattainment area to adopt and submit a revised State Implementation Plan (SIP) that meets the requirements of Section 110 and Subpart D of the Act. The ozone plan portion of the SIP submissions must contain regulations which reflect the application of reasonably available control technology (RACT) to stationary sources for which control techniques guidelines (CTG) have been published.*

Eleven CTGs, covering fifteen VOC source categories, were published prior to January 1978. These first eleven CTGs were:

- Surface Coating of Cans, Coils, Paper, Fabric, Automobiles, and Light Duty Trucks (EPA-450/2-77-008).
- Surface Coating of Metal Furniture (EPA-450/2-77-032).
- Surface Coating for Insulation of Magnetic Wire (EPA-450/2-77-033).
- Surface Coating of Large Appliances (EPA-450/2-77-034).
- Storage of Petroleum Liquids in Fixed Roof Tanks (EPA-450/2-77-036).
- Bulk Gasoline Plants (EPA-450/2-77-035).
- Solvent Metal Cleaning (EPA-450/2-77-022).
- Use of Cutback Asphalt (EPA-450/2-77-037).
- Refinery Vacuum Producing Systems, Wastewater Separators, and Process Unit Turnarounds (EPA-450/2-77-025).
- Hydrocarbons from Tank Gasoline Loading Terminals (EPA-450/2-77-026).
- Design Criteria for Stage I Vapor Control Systems, Gasoline Service Stations, U.S. EPA, OAQPS, November 1975. Unpublished.

For each source category, a CTG describes the source, identifies the VOC emission points, discusses the applicable control methods, analyzes the costs required to implement the control methods, and recommends regulations for limiting VOC emissions from the source.

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*RACT regulations do not have to be adopted for these stationary sources if a state can demonstrate attainment of the ozone standard.

A document entitled Regulatory Guidance for Control of Volatile Organic Compound Emissions from 15 Categories of Stationary Sources, EPA-905/2-78-001, was published in April 1978. This document provides guidance to the states in preparing RACT regulations for the fifteen source categories listed above.

In December 1978, a document entitled Summary of Group I Control Technique Guideline Documents for Control of Volatile Organic Emissions from Existing Stationary Sources, EPA-450/3-78-120, was published. This document provides an overview of the affected source facilities, the magnitude of the VOC emissions from the facilities, and the recommended VOC emission limits.

EPA published an additional nine CTGs (Group II) in 1978. These nine CTGs covered the following source categories:

- Leaks from Petroleum Refinery Equipment (EPA-450/2-78-036).
- Surface Coating of Miscellaneous Metal Parts and Products (EPA-450/2-78-015).
- Surface Coating of Flat Wood Paneling (EPA-450/2-78-032).
- Manufacture of Synthesized Pharmaceutical Products (EPA-450/2-78-029).
- Manufacture of Pneumatic Rubber Tires (EPA-450/2-78-030).
- Graphic Arts - Rotogravure and Flexography (EPA-450/2-78-033).
- Petroleum Liquid Storage in External Floating Roof Tanks (EPA-450/2-78-047).
- Perchloroethylene Dry Cleaning Systems (EPA-450/2-78-050).
- Leaks from Gasoline Tank Trucks and Vapor Collection Systems (EPA-450/2-78-051).

A regulatory guidance document was developed from these Group II CTGs. Published in September 1979 and entitled Guidance to State and Local Agencies in Preparing Regulations To Control Volatile Organic Compounds from Ten Stationary Source Categories, EPA-450/2-79-004, this document provides assistance to state and local agencies in preparing RACT regulations for the ten industrial categories covered by the Group II documents.

In June 1980, EPA began preparation of Control Techniques Guidelines for additional source categories. Group III contains five additional source categories. Since September 1982, Group III CTG documents have been published for these five categories.

- Control of VOC Emissions from Large Petroleum Dry Cleaners (EPA-450/3-82-009).

- Control of VOC Emissions from Manufacture of High Density Polyethylene, Polypropylene, and Polystyrene Resins (EPA-450/3-83-008).

- Natural Gas/Gasoline Processing Plants (EPA-450/3-83-007).

- SOCMI Fugitive (EPA-450/3-83-006).

- SOCMI - Air Oxidation (EPA-450/3-84-015).

In August 1980, EPA began a VOC Source Screening Study. This study will result in the publication of a single document summarizing emission control technology for additional VOC source categories. The VOC source categories listed below will be addressed in this study.

- Adhesives application

- Lubrication oil manufacture

- Barge and tanker cleaning

- Plastics parts painting

- Oil and gas production storage tanks

- Solvent extraction processes

- Asphalt air blowing

- Wine making

- Beer making

- Petroleum coking processes

- Flares - petroleum refineries

- Flares - organic chemical manufacture

- Surface coating - large ships

- Surface coating - large aircraft

- Surface coating - wood furniture

C-2 GROUPS I & II CTG SUMMARIES

Summaries of Group I and II CTG documents are presented in this appendix for the convenience of the reader (Tables C-1 through C-24). These summaries have been extracted directly from two documents developed by EPA's Control Programs Development Division at Research Triangle Park, NC.[1,2] The summaries are intended to present an overview of the affected source facilities, the magnitude of the VOC emissions from the facilities, and the recommended VOC emission limits. More information about the recommended control techniques for an individual source category can be obtained by referring to the specific CTG documents. The regulatory guidance cited previously (EPA-450/2-79-004) discusses areas of difficulty in converting CTG information into regulatory language, a compilation of industry comments on CTG information after conversion into regulatory format, and identification of specific areas of industry concern. For this executive summary, information not available in the CTGs was supplemented with comments from other parties.

Group III CTGs were summarized for inclusion in this document and are found in Tables C-25 through C-29.

References for Appendix C

1. Summary of Group I Control Technique Guideline Documents for Control of Volatile Organic Emissions from Existing Stationary Sources, EPA-450/3-78-120, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1978.

2. Summary of Group II Control Technique Guideline Documents for Control of Volatile Organic Emissions from Existing Stationary Sources, EPA-450/2-80-001, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1979.

TABLE C-1. SUMMARY OF CTG DOCUMENT FOR COATING OF CANS

AFFECTED FACILITIES	Two- and three-piece can surface coating lines including the application areas and the drying ovens.
NUMBER OF AFFECTED FACILITIES	Estimated to be 460 affected facilities nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions from can coating facilities are 140,000 Mg/yr (150,000 ton/yr) which represent about 0.5 percent of the estimated nationwide VOC emissions.
VOC EMISSION RANGE PER FACILITY	Typical annual emissions from can coating lines can vary from 13 Mg (14 tons) for end sealing to 240 Mg (260 ton) for two-piece can coating for a plant average of 310 Mg (340 ton).
100 TON/YR SOURCE SIZE	Typical can coating facilities as represented in the CTG would all approach or exceed 100 TPY VOC emissions if uncontrolled.
CTG EMISSION LIMIT	The recommended VOC emission limits are: a. Sheet coating, two-piece exterior 0.34 kg/l (2.8 lb/gal)* b. Two- and three-piece interior 0.51 kg/l (4.2 lb/gal)* c. Two-piece end exterior 0.51 kg/l (4.2 lb/gal)* d. Three-piece side seam 0.66 kg/l (5.5 lb/gal)* e. End seal compound 0.44 kg/l (3.7 lb/gal)*
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended control methods can reduce VOC emissions by 60 to 100 percent.
COSTS	BASIS: 5,000 scfm facility using thermal or catalytic incineration with primary heat recovery, or adsorption with recovered solvent credited at fuel value. CAPITAL COST: $125,000 - $162,000 ANNUALIZED COST: $42,000 - $71,000 COST EFFECTIVENESS: $135 - $706 per ton VOC

* Coating minus water

TABLE C-2. SUMMARY OF CTG DOCUMENT FOR COATING OF METAL COILS

AFFECTED FACILITIES	Coil surface coating lines including the application areas, the drying ovens, and the quench areas.
NUMBER OF AFFECTED FACILITIES	Estimated to be 180 facilities nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions from coil coating facilities are 30,000 Mg/yr (33,000 ton/yr), which represent about 0.1 percent of the estimated nationwide VOC emissions.
VOC EMISSION RANGE PER FACILITY	Average annual VOC emission for a typical facility is estimated to be 180 Mg (200 ton).
100 TON/YR SOURCE SIZE	It is estimated that $2 \times 10^6 m^2$ ($2 \times 10^9 ft^2$) of coil coated could result in a potential emission of 100 tons of VOC.
CTG EMISSION LIMIT	The recommended VOC emission limit is 0.31 kg per liter of coating minus water (2.6 lb/gal).
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended control methods can reduce VOC emissions by 70 to 98 percent.
COSTS	BASIS: 15,000 scfm facility using incineration with primary heat recovery. Capital cost: ≈ $170,000 Annualized cost: ≈ $ 70,000 Cost effectiveness: $51 - $94 per ton VOC

TABLE C-3. SUMMARY OF CTG DOCUMENT FOR COATING OF FABRIC AND VINYL

AFFECTED FACILITIES	Fabric and vinyl surface coating lines including the application areas and the drying ovens. Fabric coating includes all types of coatings applied to fabric. Vinyl coating refers to any printing, decorative, or protective topcoat applied over vinyl coated fabric or vinyl sheets.
NUMBER OF AFFECTED FACILITIES	Estimated to be 130 facilities nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emission from fabric coating operations are 100,000 Mg/yr (110,000 ton/yr). The vinyl segment of the fabric industry emits about 36,000 Mg/yr (40,000 ton/yr). VOC from fabric coating represents about 0.4 percent of the estimated VOC emissions nationwide.
VOC EMISSION RANGE PER FACILITY	Average annual VOC emissions are estimated to be 850 Mg (940 ton).
100 TON/YR SOURCE SIZE	Any but the smallest fabric coating facilities should exceed emissions of 100 ton/yr of VOC.
CTG EMISSION LIMIT	The recommended VOC emission limits are: a. Fabric coating 0.35 kg per liter of coating minus water (2.9 lb/gal). b. Vinyl coating 0.45 kg per liter of coating minus water (3.8 lb/gal).
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended control methods can reduce VOC emissions by 80 to 100 percent.
COSTS	BASIS: 15,000 scfm facility using incineration with primary heat recovery or adsorption with recovered solvent credited at fuel value. Capital cost: $150,000 - $320,000 Annualized cost: $ 60,000 - $ 75,000 Cost effectiveness: $34 - $39 per ton VOC

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TABLE C-4. SUMMARY OF CTG DOCUMENT FOR SURFACE COATING OF PAPER PRODUCTS

AFFECTED FACILITIES	Paper surface coating lines including the application areas and the drying ovens. The CTG document applies to manufacturing of adhesive tapes, adhesive labels, decorated paper, book covers, office copier paper, carbon paper, typewriter ribbons, and photographic films.
NUMBER OF AFFECTED FACILITIES	SIC 2641, Paper Coating and Glazing, had 397 plants in 1967. Current estimates for this category are 290 plants nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions are 320,000 Mg/yr (350,000 ton/yr). Of this amount, the manufacture of pressure sensitive tapes and labels is estimated to emit 263,000 Mg/yr (230,000 ton/yr). Emissions from the coating of paper products represent about 1.2 percent of nationwide VOC emissions.
VOC EMISSION RANGE PER FACILITY	Emissions from typical paper coating lines can vary from 23 to 450 kg/hr (50 to 1,000 lb/hr). A plant may have 1 to 20 coating lines. It is estimated that the annual average VOC emission from paper coating plants is 1,480 Mg (1,630 ton).
100 TON/YR SOURCE SIZE	Based on the data given, a plant with one large line or two small lines can exceed 100 ton/yr of VOC emissions.
CTG EMISSION LIMIT	The recommended VOC emission limit is 0.35 kg per liter of coating minus water (2.9 lb/gal).
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended control methods can reduce VOC emissions by 80 to 99 percent.
COSTS	BASIS: 15,000 scfm facility using incineration with primary heat recovery or adsorption with recovered solvent credited at fuel value. Capital cost: $150,000 - $320,000 Annualized cost: $ 60,000 - $ 75,000 Cost effectiveness: $34 - $40 per ton VOC

TABLE C-5. SUMMARY OF CTG DOCUMENT FOR COATING IN AUTOMOBILE AND LIGHT-DUTY TRUCK ASSEMBLY PLANTS

AFFECTED FACILITIES	Automobile and light-duty truck surface coating lines including the application areas, the flashoff areas, and the drying ovens. The CTG provides no exemptions but notes that it may not be reasonable to convert an existing water-borne dip prime coating system.
NUMBER OF AFFECTED FACILITIES	Identified for the year 1977 to be 47 plants nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions from auto and light duty truck plants are 90,000 Mg/yr (100,000 ton/yr). This is about 0.3 percent of estimated VOC emissions nationwide.
VOC EMISSION RANGE PER FACILITY	Emissions from typical coating lines can vary from 270 to 1,800 kg/hr (600 to 4,000 lb/hr). Average annual emissions are estimated to be 2,380 Mg (2,620 ton) per subject plant.
100 TON/YR SOURCE SIZE	All uncontrolled coating lines at the assembly plants are expected to emit in excess of 100 tons of VOC per year.
CTG EMISSION LIMIT	The recommended VOC emission limits are: a. Prime coating 0.23 kg/l (1.9 lb/gal) minus water b. Top coating 0.34 kg/l (2.8 lb/gal) minus water c. Final repair coating 0.58 kg/l (4.8 lb/gal) minus water
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended methods can reduce VOC emissions for: a. Prime coating - 80 to 93 percent. b. Top coating - 75 to 92 percent. c. Final repair coating - not available
COSTS	BASIS: 30 - 65 units per hour facility with substantial variability in both existing operations and potentially applicable control systems. Capital cost: $6,500,000 - $50,000,000 Annualized cost: $2,000,000 - $25,000,000 Cost effectiveness: $1,000 - $4,000 per ton VOC

TABLE C-6. SUMMARY OF CTG DOCUMENT FOR COATING OF METAL FURNITURE

AFFECTED FACILITIES	Metal furniture surface coating lines including the application and flashoff areas, and the drying ovens.
NUMBER OF AFFECTED FACILITIES	Approximately 1,400 facilities would be affected nationally.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions are 90,000 Mg/yr (100,000 ton/yr). This represents about 0.3 percent of estimated VOC emissions nationwide.
VOC EMISSION RANGE PER FACILITY	Estimated average annual VOC emissions are 70 Mg (80 ton) per facility.
100 TON/YR SOURCE SIZE	For a model dip coating line, a plant coating (with no primer), 1,500,000 m^2 (16,200,000 ft^2) of shelving per year would emit about 100 ton/yr.
CTG EMISSION LIMIT	The recommended VOC emission limit is 0.36 kg per liter of coating minus water (3.0 lb/gal).
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended control methods can reduce VOC emissions by 50 to 99 percent.
COSTS	BASIS: A dip coating facility coating 7,000,000 ft^2 of shelving per year converting to water-borne or electrodeposition: Capital cost: $ 3,000 - $124,000 Annualized cost: $11,000 - $ 25,000 Cost effectiveness: $440 - $657 per ton VOC

TABLE C-7. SUMMARY OF CTG DOCUMENT FOR COATING OF MAGNETIC WIRE

AFFECTED FACILITIES	Wire coating oven.
NUMBER OF AFFECTED FACILITIES	Estimated to be 30 plants nationwide. It is not unusual for a wire coating plant to have 50 coating ovens.
VOC EMISSIONS NATIONWIDE	CTG states that there is no way to know how much solvent is actually emitted. About 29,500 metric tons (32,500 ton) of solvent are used each year but much of this is controlled.
VOC EMISSION RANGE PER FACILITY	Emissions from a typical uncontrolled oven will be approximately 12 kg/hr (26 lb/hr). The average annual emissions of VOC per plant are estimated to be 314 Mg (340 ton).
100 TON/YR SOURCE SIZE	CTG indicates that each of the facilities, if uncontrolled, could easily exceed 100
CTG EMISSION LIMIT	The recommended VOC emission limit is 0.20 kg per liter of coating minus water (1.7 lb/gal).
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended control methods can reduce VOC emissions by 90 percent.
COSTS	BASIS: 10,000 scfm facility controlling VOC by use of incineration with primary heat recovery. Capital cost: Approximately $220,000 Annualized cost: $85,000 - $115,000 Cost effectiveness: $105 - $140 per ton VOC

TABLE C-8. SUMMARY OF CTG DOCUMENT FOR COATING OF LARGE APPLIANCES

AFFECTED FACILITIES	Large appliance surface coating including the prime, single, or topcoat application areas, the flashoff areas, and the oven.
NUMBER OF AFFECTED FACILITIES	Estimated to be about 270 plants nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions are 42,000 Mg/yr (46,000 ton/yr) which represent about 0.2 percent of estimated nationwide VOC emissions.
VOC EMISSION RANGE PER FACILITY	The average annual VOC emissions are estimated to be 170 Mg (185 ton).
100 TON/YR SOURCE SIZE	Extrapolating the model facility data, a plant coating 221,000 clothes washer cabinets per year would exceed 100 ton/yr emissions of uncontrolled VOC.
CTG EMISSION LIMIT	The recommended VOC emission limit is 0.34 kg per liter of coating minus water (2.8 lb/gal).
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended control methods can reduce VOC emissions by 79 to 95 percent.
COSTS*	BASIS: 768,000 clothes washer cabinets coated per year using various combinations of control techniques. Capital cost: $70,000 - $1,250,000 Annualized cost: ($300,000) - $350,000 Cost effectiveness: ($1,050) - $1,180 per ton VOC

* ($---) indicates savings

TABLE C-9. SUMMARY OF CTG DOCUMENT FOR TANK TRUCK GASOLINE LOADING TERMINALS

AFFECTED FACILITIES	Any tank truck loading operations at the primary wholesale outlet for gasoline which delivers at least 76,000 liter/day (20,000 gal/day). A facility which delivers under 20,000 gal/day is covered by the CTG for bulk plants.
NUMBER OF AFFECTED FACILITIES	According to the Bureau of Census, there were 1,925 terminals in 1972. Current estimates are about 1,600 terminals nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions are 250,000 Mg/yr (275,000 ton/yr) which represent about 0.9 percent of estimated VOC emissions nationwide.
VOC EMISSION RANGE PER FACILITY	Without vapor recovery systems, VOC emissions can range from 0.6 to 1.4 g/1,000 liters of throughput (5 to 12 lb/1,000 gal). For a typical size facility having a throughput of 950,000 liter/day (250,000 gal/day) VOC emissions are estimated to be 200 Mg/yr (220 ton/yr).
100 TON/YR SOURCE SIZE	For an uncontrolled facility with fixed roof tanks, a 133,000 liter /day (35,000 gal/day) plant would result in VOC emission of 100 ton/yr. For an uncontrolled facility with floating roof tanks, a 454,000 liter/ day (120,000 gal/day) facility would result in VOC emissions of 100 ton/yr.
CTG EMISSION LIMIT	The recommended emission limit is 80 mg/liter (0.67 lb/1,000 gal) of gasoline loaded. This limit is based on submerged fill and vapor recovery/control systems. No leaks in the vapor collection system during operation is a requirement.
VOC REDUCTION PER FACILITY	A minimum control of 87 percent is expected for the loading facility.
COSTS	BASIS: 250,000 gal/day facility with active vapor control systems. Capital cost: $140,000 - $195,000 Annualized cost: $ 20,000 - $ 30,000 Cost effectiveness: $120 - $180 per ton VOC

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TABLE C-10. SUMMARY OF CTG DOCUMENT FOR BULK GASOLINE PLANTS

AFFECTED FACILITIES	A wholesale gasoline distribution facility which has a maximum daily throughput of 76,000 liters (20,000 gal) of gasoline. Facilities which deliver over 20,000 gal/day are covered under the CTG for terminals. Potentially severe economic hardship may be encountered by bulk plants which deliver less than 4,000 gal/day.
NUMBER OF AFFECTED FACILITIES	There were 23,367 bulk plants in 1972 according to the Bureau of Census. Current estimates are about 18,000 bulk gasoline plants nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions are 150,000 Mg/yr (165,000 ton/yr) which represent about 0.6 percent of estimated VOC emissions nationwide.
VOC EMISSION RANGE PER FACILITY	A facility with three storage tanks would have VOC emissions approximating 4.4 kg/day (20 lb/day) plus a range of 0.2 to 3.0 g/1,000 liters throughput (2.0 to 25.0 lb/1,000 gal). For a typical size facility having a throughput of 18,900 liter/day (5,000 gal/day) average VOC emissions are estimated to be 15 Mg/yr (17 ton/yr).
100 TON/YR SOURCE SIZE	None.
CTG EMISSION LIMIT	Emission limits recommended in terms of equipment specification alternatives: 1. Submerged fill of outgoing tank trucks. 2. Alternative 1 + vapor balance for incoming transfer. 3. Alternative 2 + vapor balance for outgoing transfer.
VOC REDUCTION PER FACILITY	

Emission Reductions	Total Plant	All Transfers
Alternative 1	22 percent	27 percent
Alternative 2	54 percent	64 percent
Alternative 3	77 percent	92 percent

COSTS	BASIS: 4,000 gal/day throughput using submerged fill and vapor balance for both incoming and outgoing transfers: Capital cost: $4,000 - $10,000 Annualized cost: $ 100 - $ 1,200 Cost effectiveness: $9 - $90 per ton VOC

TABLE C-11. SUMMARY OF CTG DOCUMENT FOR GASOLINE SERVICE STATIONS - STAGE I

AFFECTED FACILITIES	Transfer of gasoline from delivery trucks to service station storage tanks. No exemptions were noted in the "Design Criteria for Stage I Vapor Control Systems."
NUMBER OF AFFECTED FACILITIES	Estimated to be 180,000 retail gasoline service stations nationwide. There are 240,000 other gasoline dispensing outlets.
VOC EMISSIONS NATIONWIDE	For transfer of gasoline to service station storage tanks, VOC emissions estimated to be 400,000 Mg/yr (440,000 ton/yr) which represents about 1.5 percent of estimated VOC emissions nationwide.
VOC EMISSION RANGE PER FACILITY	Without vapor controls, VOC emissions are estimated to be 1.4 kg/1,000 liters (11.5 lb/1,000 gal) of throughput. For a typical facility having a throughput of 151,000 liter/mo (40,000 gal/mo) VOC emissions would be 2.5 Mg/yr (2.8 ton/yr) for Stage I.
100 TON/YR SOURCE SIZE	For an uncontrolled facility, a 2,800,000 liter/mo (750,000 gal/mo) throughput results in VOC emissions of 100 ton/yr. Very few service stations will have this size throughput. The emissions include both Stage I and Stage II losses.
CTG EMISSION LIMIT	Emission limits recommended in terms of equipment specifications. Recommended controls are submerged fill of storage tanks, vapor balance between truck and tank, and a leak free truck and vapor transfer system.
VOC REDUCTION PER FACILITY	Stage I control can reduce transfer losses by 95+ percent and total facility losses by 50 percent.
COSTS*	BASIS: Application of submerged fill and vapor balance to a service station with three tanks. Capital cost: $600 Annualized cost: ($200) Cost effectiveness: ($110) per ton VOC

* ($---) indicates savings

TABLE C-12. SUMMARY OF CTG DOCUMENT FOR PETROLEUM LIQUID STORAGE IN FIXED-ROOF TANKS

AFFECTED FACILITIES	Fixed-roof storage tanks having a capacity greater than 150,000 liters (40,000 gal or 950 bbl) and storing petroleum liquids which have a true vapor pressure greater than 10.5 kPa (1.5 psia). Fixed-roof tanks which have capacities less than 1,600,000 liters (420,000 gal or 10,000 bbl) used to store produced crude oil and condensate prior to lease custody transfer are exempt.
NUMBER OF AFFECTED FACILITIES	Estimated for the year 1976 to be 7,300 tanks nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions are 560,000 Mg/yr (616,000 ton/yr) which represent about 2.1 percent of the estimated VOC emissions nationwide. Emissions of VOC from fixed-roof tanks are 4.7 times that from existing floating roof tanks, although the total capacity of fixed-roof tank storage is less.

VOC EMISSION RANGE PER FACILITY

VOC emission ranges for gasoline or crude oil storage assuming 5 to 20 turnovers per year and a true vapor pressure of 13.8 to 69 kPa (2.0 to 10 psia).

Size →	Small	Medium	Large
Capacity (gal)	420×10^3	2.3×10^6	6.3×10^6
Dimensions diam. x ht. (ft)	50 x 30	100 x 40	150 x 48
VOC Emissions Gasoline (Mg/yr)	12 - 113	52 - 535	123 - 1,353
(ton/yr)	13 - 125	57 - 590	135 - 1,490
Crude Oil (Mg/yr)	7 - 65	28 - 311	66 - 796
(ton/yr)	8 - 72	30 - 340	75 - 875

100 TON/YR SOURCE SIZE	Variable depending on many parameters including the type and vapor pressure of the petroleum liquid stored, schedule of tank filling and emptying, and the geographic location of tank. As shown above a medium size tank can easily exceed 100 ton/yr emissions of VOC.
CTG EMISSION LIMIT	Emission limits recommended in terms of equipment specifications: Installation of internal floating roofs or alternative equivalent control. Types of alternative controls are not specified in the CTG document.
VOC REDUCTION PER FACILITY	VOC emission reduction of 90+ percent can be achieved by installation of internal floating roofs.
COSTS*	BASIS: 55,000 bbl (2,310,000 gal) medium size tank with gasoline or crude oil, with true vapor pressure range of 14 to 69 kPa (2 to 10 psia) and 5 to 20 turnovers per year. Capital cost: $31,000 Annualized cost: $(70,000) to 2,100 Cost effectiveness: ($123) - $73 per ton VOC

* ($-) indicates savings

TABLE C-13. SUMMARY OF CTG DOCUMENT FOR PROCESSES AT PETROLEUM REFINERIES

AFFECTED FACILITIES	The affected facilities and operations are: a. Vacuum producing systems (VPS) b. Wastewater separators (WS) c. Process unit turnarounds (PUT) - (i.e., shutdown, repair or inspection, and start up of a process unit) The CTG provides no exemptions.
NUMBER OF AFFECTED FACILITIES	No estimates of the number of individual facilities are available. There are approximately 285 refineries nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual nationwide emissions from vacuum producing systems (VPS), wastewater separators (WS), and process unit turnarounds (PUT) are 730,000 Mg/yr (800,000 ton/yr) which represent about 2.7 percent of estimated VOC emissions nationwide.
VOC EMISSION RANGE PER FACILITY	The estimated average annual VOC emissions from affected facilities at a petroleum refinery are 2,560 Mg (2,820 ton). Emission factors used for estimating uncontrolled, reactive VOC emissions are: a. VPS - 145 kg/10^3 m^3 (50 lb/10^3 bbl) refinery throughput b. WS - 570 kg/10^3 m^3 (200 lb/10^3 bbl) refinery throughput c. PUT - 860 kg/10^3 m^3 (301 lb/10^3 bbl) refinery throughput
100 TON/YR SOURCE SIZE	The following annual refinery throughputs will result in 100 ton/yr uncontrolled VOC emissions from each affected facility type: a. VPS - 627 x 10^3 m^3 (3.9 x 10^6 bbl) b. WS - 160 x 10^3 m^3 (1.0 x 10^6 bbl) c. PUT - 105 x 10^3 m^3 (0.67 x 10^6 bbl)
CTG EMISSION LIMIT	Emission limits recommended in terms of equipment specifications: a. VPS - incineration of VOC emissions from condensers b. WS - covering separator forebays c. PUT - combustion of vapor vented from vessels
VOC REDUCTION PER FACILITY	Implementing the recommended controls can reduce VOC emissions by: a. VPS - 100 percent b. WS - 95 percent c. PUT - 98 percent.
COSTS*	BASIS: A 15,900 m^3/day (100,000 bbl/day) refinery using the recommended control equipment. VPS / W S / PUT - 10 units Capital cost $1,000: 24 - 52 / 63 / 98 Annualized cost $1,000: (95) - (89) / (310) / 26 Cost effectiveness $/ton : (104) - (96) / (90) / 5

* ($-) indicates savings

TABLE C-14. SUMMARY OF CTG DOCUMENT FOR CUTBACK ASPHALT

AFFECTED FACILITIES	Roadway construction and maintenance operations using asphalt liquefied with petroleum distillates.
NUMBER OF AFFECTED FACILITIES	No estimates were obtained.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions are 655,000 Mg/yr (720,000 ton/yr). This represents about 2.4 percent of estimated VOC emissions nationwide.
VOC EMISSION RANGE PER FACILITY	Estimated VOC emissions from cutback asphalt production are: a. 0.078 kg/kg (ton/ton) of slow cure asphalt. b. 0.209 kg/kg (ton/ton) of medium cure asphalt. c. 0.204 kg/kg (ton/ton) of rapid cure asphalt.
100 TON/YR SOURCE SIZE	Not generally applicable to this source category since the main sources of emissions are the road surfaces where the asphalt is applied.
CTG EMISSION LIMIT	Substitute water and nonvolatile emulsifier for petroleum distillate blending stock.
VOC REDUCTION PER FACILITY	VOC emission reductions are approximately 100 percent.
COSTS*	BASIS: The major cost associated with control of VOC is the price difference between cutback and emulsified asphalt. A price differential of 5 cent/gallon savings to 1 cent/gallon penalty results in a cost effectiveness range of ($73) - $15 per ton VOC.

* ($---) indicates savings

TABLE C-15. SUMMARY OF CTG DOCUMENT FOR SOLVENT METAL CLEANING

AFFECTED FACILITIES	Three types of solvent degreasers are affected: a. Cold cleaner: batch loaded, nonboiling solvent degreaser. b. Open top vapor degreaser: batch load, boiling solvent degreaser. c. Conveyorized degreaser: continuously loaded, conveyorized solvent degreaser, either boiling or nonboiling. Open top vapor degreasers smaller than 1 m^2 of open area are exempt from the application of refrigerated chillers or carbon adsorbers. Conveyorized degreasers smaller than 2.0 m^2 of air/vapor interface are exempt from a requirement for a major control device.
NUMBER OF AFFECTED FACILITIES	Estimates of the number of solvent degreasers nationwide for the year 1974 are: a. Cold cleaners (CC) - 1,220,000. b. Open top vapor degreasers (OT) - 21,000. c. Conveyorized degreasers (CD) - 3,700.
VOC EMISSIONS NATIONWIDE	Estimates of annual nationwide emissions are: a. CC - 380,000 Mg/yr (419,000 ton/yr). b. OT - 200,000 Mg/yr (221,000 ton/yr) c. CD - 100,000 Mg/yr (110,000 ton/yr) which represent about 2.5 percent of estimated VOC emissions nationwide.
VOC EMISSION RANGE PER FACILITY	Averaged emission rates per degreaser: a. CC - 0.3 Mg/yr (0.3 ton/yr). b. OT - 10 Mg/yr (11 ton/yr). c. CD - 27 Mg/yr (30 ton/yr).
100 TON/YR SOURCE SIZE	Data indicate that on an average 10 open top degreasers or 4 conveyorized degreasers may emit 100 ton/yr.
CTG EMISSION LIMIT	The VOC emission limit is recommended in terms of equipment specifications and operation procedures. Required control equipment can be as simple as a manually operated tank cover or as complex as a carbon adsorption system depending on the type, size, and design of the degreaser.
VOC REDUCTION PER FACILITY	The actual percent VOC reduction will vary depending on the control equipment installed and the operational procedures followed. Recommended control methods can reduce VOC emissions by: a. CC - 50 to 53 percent (± 20 percent). b. OT - 45 to 60 percent (± 15 percent). c. CD - 25 to 60 percent (± 10 percent).
COSTS *	BASIS: CC of 0.5 m^2 work area using high volatility solvent (a) and low volatility solvent (b); OT of 1.67 m^2 work area; and CD of 3.9 m^2 work area.

	Capital Cost $1,000	Annualized Cost $1,000	Cost Effectiveness $/ton VOC
CC-a	0.025	0.001	20
CC-b	0.065	(0.026)	(240)
OT	0.3 - 10.3	(0.8) - 0.8	(360) - 220
CD	7.5 - 18	(3.7) - 1.5	(260) - 260

* ($---) indicates savings

TABLE C-16. SUMMARY OF CTG DOCUMENT FOR SURFACE COATING OF MISCELLANEOUS METAL PARTS AND PRODUCTS

Affected facilities (p. 1-2)*	Coating application areas, flashoff areas, dryers, and ovens for manufacturers of: a. Large farm machinery b. Small farm machinery c. Small appliances d. Commercial machinery e. Industrial machinery f. Fabricated metal products g. Any other industrial category, which coats metals, under SIC major groups 33-39, inclusive. Except those facilities which are covered by previous CTGs.
Number of affected facilities	96,000
VOC emissions nationwide	9.0×10^5 Mg/yr (1×10^6 tons/yr) estimated for 1977, which represents about 5.0 percent of stationary source estimated emissions.
VOC emission range per facility (pp. 1-10, 2-3)*	a. An emission factor of 0.66 kg VOC/l coating less water (5.5 lb VOC/gal coating less water) can be expected from a facility utilizing a coating composed of 75 percent organic solvent, 25 percent solids by volume. b. For facilities utilizing an electrodeposition process the VOC emission factor is 0.36 kg VOC/l coating less water (3.0 lb/gal).
100 tons/yr source size (calculated)	An emission factor of 5.5 lb VOC/gal implies that a minimum process rate of 3.64×10^6 gal coating material/yr would be required for a facility to be a potential 100 tons/yr source.
CTG emission limit (p. v)*	Coating method — Recommended limitation (wt. VOC / vol. coating) a. Air or forced air dried items — 0.42 kg/l (3.5 lb/gal) b. Clear coat — 0.52 kg/l (4.3 lb/gal) c. No or infrequent color change or small number of colors applied 1. Powder coatings — 0.05 kg/l (0.4 lb/gal) 2. Other — 0.36 kg/l (3.0 lb/gal) d. Outdoor, harsh exposure or extreme performance characteristics — 0.42 kg/l (3.5 lb/gal) e. Frequent color change, large number of colors applied, or first coat on untreated ferrous substrate — 0.36 kg/l (3.0 lb/gal)
VOC reduction per facility (p. 2-1)*	Percent reduction in VOC emissions Process modification (coating/equipment change) 50-98 Exhaust gas treatment 90+
Costs (pp. 3-8 to 3-14)*	Basis: A medium size coating line (~ 743,000 m^2/yr, ~ 8×10^6 ft^2/yr) with single or two coat operation using flow-coat, dip-coat, or spray-coat applications. The ranges cover the costs of several different VOC control options. Capital cost ($1000): 20-1,837 Annualized cost ($1000): (27)†-602 Cost effectiveness ($/Mg): (290)†-6,841 ($/ton): (263)†-6,206

*The source of the summary information is the indicated page number in "Control of Volatile Organic Emissions from Existing Stationary Sources, Volume VI: Surface Coating of Miscellaneous Metal Parts and Products," EPA-450/2-78-015.

†Numbers in parentheses are savings.

TABLE C-17. SUMMARY OF CTG DOCUMENT FOR FACTORY SURFACE COATING OF FLATWOOD PANELING

Affected facilities (p. 1-2)*	The affected facilities are factories that surface coat the following types of flat wood panels: a. Hardwood plywood b. Particleboard c. Hardboard
Number of affected facilities (p. 1-2)*	Affected Facilities — Nationwide Total a. Hardwood plywood — 247 b. Particleboard — 80 c. Hardboard — 67
VOC emissions nationwide	8.4×10^4 Mg/yr (9.3×10^4 tons/yr) estimated for 1977 which represents about 0.5 percent of stationary source estimated emissions.
VOC emission range per facility (Table 2-2 p. 2-5)*	Potential VOC emissions per coated surface area are: 0.4 to 8.0 kg/100 m^2 (0.8 to 16.5 lb/1000 ft^2) depending on the coating/curing process as well as the coating materials used.
100 tons/yr source size (calculated)	Based on the VOC emission range above, a 100 tpy source would cost a minimum annual throughput of: 3.8×10^5 to 7.7×10^6 standard panels/yr Where a standard panel is 2.97 m^2 (32 ft^2).
CTG emission limit (p. v)*	Recommended limitation Printed hardwood plywood and particleboard — 2.9 kg VOC/100 m^2 (6.0 lb VOC/1000 ft^2) Natural finish hardwood plywood — 5.8 kg VOC/100 m^2) (12.0 lb VOC/1000 ft^2) Class II† finishes for hardboard paneling — 4.8 kg VOC/100 m^2) (10.0 lb VOC/1000 ft^2)
VOC reduction per facility (Table 2-1 p. 2-4)*	70 to 90 percent VOC emission reduction, depending on coating material and coverage, through use of water-borne coatings, incineration, adsorption, ultraviolet curing or electron beam curing.

Costs (Table 3-2 p. 3-9)*

Basis:

Shifts:	1		2	
Panels/yr:	2,000,000		4,000,000	
	Waterborne	UV/Waterborne	Waterborne	UV/Waterborne
Capital cost ($1000)	52	155	52	155
Annualized cost ($1000)	101	124.6	200.8	234.4
Cost effectiveness ($/Mg)	269	292	256	264
($/ton)	244	264	232	240

*The source of the summary information is the indicated page number in "Control of Volatile Organic Emissions from Existing Stationary Sources, Volume VII: Factory Surface Coating of Flat Wood Paneling," EPA-450/2-78-032.

†Definition on p. vii of EPA-450/2-78-032.

TABLE C-18. SUMMARY OF CTG DOCUMENT FOR MANUFACTURE OF SYNTHESIZED PHARMACEUTICAL PRODUCTS

Affected facilities (p. 1-4)*	Synthesized pharmaceutical manufacturing facilities. Specific sources include: 1. Dryers 2. Reactors 3. Distillation Units 4. Storage and transfer of VOC 5. Filters 6. Extraction equipment 7. Centrifuges 8. Crystallizers.
Number of affected facilities (p. 1-2)*	Estimated 800 plants nationwide
VOC emissions nationwide	50,000 Mg/yr (55,000 tons/yr) estimated for 1977 which represents about 0.3 percent of stationary source estimated VOC emissions.
VOC emission range per facility	Not available
100 ton/yr source size	Not available
CTG emission limit (p. 1-5)*	1. a. Surface condensers or equivalent control on vents from reactors, distillation operations, crystallizers, centrifuges, and vacuum dryers that emit 6.8 kg/day (15 lb/day) or more VOC. b. Surface condensers must meet certain temperature versus VOC vapor pressure criteria. 2. Additional specific emission reductions are required for air dryers, production equipment exhaust systems, and storage and transfer of VOC. 3. Enclosures or covers are recommended for rotary vacuum filters, processing liquid containing VOC and in-process tanks. 4. Repair of components leaking liquids containing VOC.
VOC reduction per facility	Not available
Costs (pp. 3-14 to 3-42)*	Capital and Annualized Cost graphs are provided for the following types of control equipment: conservation vents, floating roofs, pressure vessels, carbon adsorption systems, thermal and catalytic incineration systems, water cooled condensers, chilled water and brine cooled condensers, freon cooled condensers, packed bed scrubbers and venturi scrubbers. Cost effectiveness data is not calculated for typical plants.

*The source of the summary information is the indicated page(s) in "Control of Volatile Organic Emissions from Manufacture of Synthesized Pharmaceutical Products," EPA-450/2-78-029.

TABLE C-19. SUMMARY OF CTG DOCUMENT FOR MANUFACTURE OF PNEUMATIC RUBBER TIRES

Affected facilities (pp. 1-1, 1-3)*	Rubber tire manufacturing plants, producing passenger car, and light and medium duty truck tires. Operations affected are: undertread cementing, bead dipping, tread end cementing, and green tire spraying.
Number of affected facilities (p. 2-2)*	Maximum of 62 rubber tire plants nationwide
VOC emissions nationwide (p. 1-2)*	1976 VOC emissions estimate from rubber tire manufacturing totalled 88,200 Mg/yr (97,200 tons/yr). This quantity represents 0.6 percent of total national VOC emissions from stationary sources.
VOC emission range per facility (p. 1-2)*	The average tire plant is estimated to release 4,000 kg per day (8,820 lb/day) of emissions or 1,000 Mg VOC per year (1,100 tons/yr).
100 tons/yr source size (p. 2-8)*	The model plant, producing 16,000 tires/day, has potential to emit 1,460 Mg/yr (1,600 tons VOC/yr). Therefore a plant producing approximately 1,000 tires/day would be a potential 100 tons/yr source.
CTG emission limit (p. 4-2)*	VOC emissions reduction from the affected operations is recommended through use of carbon adsorption or incineration. Water-based coatings may be used for green tire spraying.
VOC reduction per facility (p. 1-4)*	a. Carbon adsorption gives an overall efficiency of 62-86 percent in reducing VOC emissions, when applied to the affected operations. b. Incineration gives an overall efficiency of 59-81 percent when applied to the affected operations. c. Water-based coatings, applied to green tire spraying, provide an overall emission reduction efficiency of 97 percent.
Costs (pp. 4-11, 4-15)*	Basis: A model 16,000 tires/day plant using the various control technologies recommended on the following affected operations. All costs are based on January 1978 dollars.

	Undertread cementing	Bead dipping	Tread end cementing	Green tire spraying
Capital cost ($1000)	130-340	115-250	135-375	15-450
Annualized cost ($1000)	92-280	70-985	100-340	118-490
Cost effectiveness ($/Mg)	166-505	1,430-20,800	1,140-3,880	202-839
($/ton)	150-458	1,340-18,800	1,000-3,500	184-763

*The source of the summary information is the indicated page(s) in "Control of Volatile Organic Emissions from Manufacture of Pneumatic Rubber Tires," EPA-450/2-78-030.

TABLE C-20. SUMMARY OF CTG DOCUMENT FOR GRAPHIC ARTS - ROTOGRAVURE AND FLEXOGRAPHY

Affected facilities (p. 1-1)*	Flexographic and rotogravure processes applied to publication and packaging printing.
Number of affected facilities (p. 2-5)*	a. Publication printing is done in large printing plants, numbering less than 50 in total. b. There are approximately 13 to 14 thousand gravure printing units and 30 thousand flexographic printing units.
VOC emissions nationwide (p. 2-8)*	a. Gravure 100,000 Mg/yr 1976 (110,000 tons/yr) b. Flexography 30,000 Mg/yr 1976 (33,000 tons/yr) This represents about 0.8 percent of stationary source estimated emissions.
VOC emission range per facility (calculated)	a. Gravure 7.4 Mg/printing unit per year (8.2 tons/unit) b. Flexography 1 Mg/printing unit per year (1.1 tons/printing unit per year)
100 tons/yr source size	A plant will be a potential 100 tons/yr VOC source if it uses 110-180 Mg (120-200 tons) of ink per year, where the solvent concentration is 50-85 percent.
CTG emission limit (pp. 1-2, 1-3)*	Use of water-borne or high solids inks meeting certain composition criteria or the use of capture and control equipment which provides: a. 75 percent overall VOC reduction where a publication rotogravure process is employed; b. 65 percent overall VOC reduction where a packaging roto-rotogravure process is employed; or, c. 60 percent overall VOC reduction where a flexographic printing process is employed.
VOC reduction per facility	Same as CTG limit above.

Costs (pp. 4-8 4-13)*

VOC control option	Incinerator	Incinerator	Carbon adsorption	Carbon adsorption
Ink usage, Mg/yr (tons/yr)	7 (7.7)	2,500 (2,750)	3,500 (3,860)	7,000 (7,720)
VOC concentration ppm	500	500	1,200	2,400
Capital cost	94,000	1,110,000	701,000	701,000
Annualized cost	24,900	1,665,500	72,800	(41,700)†
Cost effectiveness $/Mg	8,360	1,650	51	(15)†
$/ton	7,570	1,480	46	(13)†

*The source of the summary information is the indicated page number in "Control of Volatile Organic Emissions from Existing Stationary Sources, Volume VIII: Graphic Arts — Rotogravure and Flexography," EPA-450/2-78-033.

†Numbers in parentheses are savings.

TABLE C-21. SUMMARY OF CTG DOCUMENT FOR PERCHLOROETHYLENE DRY CLEANING SYSTEMS

Affected facilities (p. 2-1)*	Affected facilities are coin-operated, commercial, and industrial dry cleaning systems which utilize perchloroethylene as solvent.
Number of affected facilities (calculated)	a. Coin-op 14,900 b. Commercial 44,600 c. Industrial 230
VOC emissions nationwide (pp. 1-2, 2-1)*	a. Coin-op 21,400 Mg/yr (23,500 tons/yr) b. Commercial 123,000 Mg/yr (135,000 tons/yr) c. Industrial 13,600 Mg/yr (15,000 tons/yr) The estimated 158,000 Mg VOC/yr is 0.9 percent of total stationary source estimated emissions.
VOC emission range per facility (p. 5-2)*	Uncontrolled VOC emissions Type of plant — kg/yr — (lb/yr) a. Coin-op 1,460 (3,200) b. Commercial 3,240 (7,200) c. Industrial 32,400 (72,000)
100 tons/yr source size (extrapolated)	A large industrial dry cleaning plant, processing 750 Mg (825 tons) of clothes per year, would be a potential 100 tons VOC per year source.
CTG emission limit (pp. 6-1 — 6-4)*	a. Reduction of dryer outlet concentration to less than 100 ppm VOC, by means of carbon adsorption. (Facilities with inadequate space or steam capacity for adsorbers are excluded.) b. Reduction of VOC emissions from filter and distillation wastes. c. Eliminate liquid and vapor leaks.
VOC reduction per facility (pp. 2-5, 2-7)*	Carbon adsorption applied to commercial and industrial plants will reduce overall VOC emissions by 40-75 percent.
Costs (p. 4-5)*	Basis: Carbon adsorbers for a commercial plant cleaning 46,000 kg (100,000 lb) of clothes per year. Capital cost $4,500 Annualized cost $300 Cost effectiveness $90 credit/Mg $80 credit/ton

*The source of the summary information is the indicated page number in "Control of Volatile Organic Emissions from Perchloroethylene Dry Cleaning Systems," EPA-450/2-78-050.

TABLE C-22. SUMMARY OF CTG DOCUMENT FOR LEAKS FROM PETROLEUM REFINERY EQUIPMENT

Affected facilities (p. 6-1)*	Petroleum refinery equipment including pump seals, compressor seals, seal oil degassing vents, pipeline valves, flanges and other connections, pressure relief devices, process drains, and open ended pipes.
Number of affected facilities	There were 311 petroleum refineries in the nation as of January 1, 1979.
VOC emissions nationwide (p. 5-1)*	The estimated VOC emissions nationwide are 170,000 Mg/year, or about 1 percent of the total VOC emissions from stationary sources.
VOC emissions range per facility (p. 3-2)*	The potential VOC emissions per leaking source range from 1.0 to 10 kg/day.
100 ton/year source size (p. 1-3, 2-3)*	A single leaking source has the potential to emit 0.4 to 3.7 Mg VOC/year (0.5 to 4.1 ton/yr). A refinery with between 25 and 227 leaking components would emit 100 tons/year of VOC. A model medium size refinery may have 90,000 leaking components.
CTG emission limits (p. 1-3)*	If a leaking component has a VOC concentration of over 10,000 ppm at the potential leak source, it should be scheduled for maintenance and repaired within 15 days.
VOC reduction per facility (calculated)	Estimated to prevent the release of 1821.1 Mg/year (2007.4 ton/year) of VOC at a model medium size refinery (15,900 m^3/day) by reducing emissions from 2933.6 Mg (3233.5 ton) to 1112.5 Mg (1226.1 ton) per year
Costs (p. 4-8)*	Basis: A monitoring and maintenance program for a 15,900 m^3/day (100,000 bbl/day) refinery (Fourth quarter 1977 dollars). Instrumentation Capital Cost 8,800 Total Annualized Costs 115,000 Cost Effectiveness $/Mg (86.85)† $/ton (78.81)†

*The source of the summary information is the indicated page number(s) in "Control of Volatile Organic Compound Leaks from Petroleum Refinery Equipment," EPA-450/2-78-036.

†Numbers in parentheses are savings.

TABLE C-23. SUMMARY OF CTG DOCUMENT FOR EXTERNAL FLOATING ROOF TANKS

Affected facilities (p. 1-2)*	External floating roof tanks larger than 150,000 liters (40,000 gal) storing petroleum liquids. See exceptions noted in text.
Number of affected facilities (p. 2-1)*	There is an estimated 13,800 internal and external floating roof tanks that are larger than 150,000 liters (40,000 gal). The number of external floating roof tanks is not available.
VOC emissions nationwide (p. 1-2)*	An estimated 65,000 Mg (71,630 tons) of VOC was emitted in 1978 which represents about 4.0 percent of stationary source estimated emissions.
VOC emission range per facility (pp. 3-3, 3-9)*	The emission range for a 30.5 m (100 ft) diameter tank storing 41.4 kPa (6 psi) vapor pressure gasoline is 212 Mg/yr (233 tons/yr) for a slightly gapped primary seal to 2.2 Mg/yr (2.4 tons/yr) for a tight rim-mounted secondary seal over a tight primary seal.
100 tons/yr source size	No single floating roof tank is expected to emit more than 100 tons/yr.
CTG emission limit (pp. 5-1, 5-4)*	A continuous secondary seal or equivalent closure on all affected storage tanks, plus certain inspection and recordkeeping requirements.
VOC reduction per facility (pp. 3-3, 3-9)*	Ranges from about 200 to 2 Mg/yr (220 to 2.2 tons/yr).
Costs (pp. 4-9, 4-12)*	Basis: External floating roof tank 30.5 m (100 ft) in diameter with a capacity of 8.91×10^6 liters (55,000 bbl) controlled by a rim mounted secondary seal. Capital cost ($1000): 16.9 Annualized cost ($1000): 3.3 Cost effectiveness ($/Mg): (66)†-3,655 ($/ton): (59)†-3,316

*The source of the summary information is the indicated page(s) in "Control of Volatile Organic Emissions from Petroleum Liquid Storage in External Floating Roof Tanks," EPA-450/2-78-047.

†Numbers in parenthesis indicate credits.

TABLE C-24. SUMMARY OF CTG DOCUMENT FOR LEAKS FROM GASOLINE TANK TRUCKS AND VAPOR COLLECTION SYSTEMS

Affected facilities (p. 2)*	a. Gasoline tank trucks that are equipped for vapor collection. b. Vapor collection systems at bulk terminals, bulk plants, and service stations that are equipped with vapor balance and/or vapor processing systems.
Number of affected facilities	Not available
VOC emissions nationwide	Not available
VOC emission range per facility	Not available
CTG emission limit (pp. 1 and 2)	The control approach is a combination of testing, monitoring, and equipment design to ensure that good maintenance practices are employed to prevent leaks from truck tanks or tank compartments and vapor collection systems during gasoline transfer at bulk plants, bulk terminals, and service stations. A leak is a reading greater than or equal to 100 percent of the LEL at 2.5 cm from a potential leak source as detected by a combustible gas detector.
VOC reduction per facility	Not available
Costs	Not available

*The source of the summary information is the indicated page number in "Control of Volatile Organic Compound Leaks from Gasoline Tank Trucks and Vapor Collection Systems," EPA-450/2-78-051.

TABLE C-25.

SUMMARY OF CTG DOCUMENT FOR VOLATILE ORGANIC COMPOUND EMISSIONS FROM LARGE PETROLEUM DRY CLEANERS

AFFECTED FACILITIES (p. 2-1)	Only large facilities that use petroleum dry cleaning solvents.
NUMBER OF AFFECTED FACILITIES (p. 2-2)	Approximately 230 industrial plants used petroleum dry cleaning solvents in 1979.
VOC EMISSIONS NATIONWIDE (p. 2-15)	The average range of baseline emissions nationwide for two model plants: (1979) I: 2,400-3,300 mg/yr (2,600-3,600 tons/yr) II: 28,800 mg/yr (26,200 tons/yr)
VOC EMISSIONS PER FACILITY (p. 2-13)	15.5 to 46 kg total plant emissions per 100 kg dry weight of articles cleaned.
100 TON/YR SOURCE SIZE (p. 2-16)	Approximately 5,400 lb/day of articles to be cleaned.
CTG EMISSION LIMIT (p. 3-26) VOC REDUCTION PER FACILITY (p. 3-25)	For model plants: Average of baseline emissions I: 819-930 mg/yr (900-1,020 tons/yr) II: 8,100 mg/yr (8,905 tons/yr) Overall plant reduction of 66 to 72 percent over existing levels.
COSTS (in thousands of June, 1980 dollars) (p. 5-7)	Capital Costs: Plant I 77.31; Plant II 169.78 Annualized Costs: Plant I 8.86; Plant II 19.34 Difference from Existing Annual Costs: Plant I (20.89); Plant II (34.23) Cost Effectiveness ($\$10^3$/mg VOC): Plant I 0.48-0.64; Plant II 0.37

TABLE C-26.

SUMMARY OF CTG DOCUMENT FOR VOLATILE ORGANIC COMPOUND EMISSIONS FROM MANUFACTURE OF HIGH-DENSITY POLYETHYLENE, POLYPROPYLENE, AND POLYSTRENE RESINS

AFFECTED FACILITIES (p. 2-1)	Industries that convert monomer or chemical intermediate materials into polymer products, including plastic materials, synthetic resins, synthetic rubbers and organic fibers covered by SIC codes 2821, 2822, 2823 and 2824.
NUMBER OF AFFECTED FACILITIES (pp. 2-2, 2-12, 2-19)	Producing: Polypropylene: 24 High Density Polyethylene (HDPE): not enumerated Polystyrene: not enumerated
VOC EMISSIONS NATIONWIDE (calculated)	Polypropylene: 64,124,970 mg/yr HDPE: 29,549,000 mg/yr Polystyrene: 472,240 - 5,905,250 mg/yr
100 TON/YR SOURCE SIZE	Data not given.
CTG EMISSION LIMIT	Polypropylene: 98% by weight Polyethylene: 98% by weight Polystyrene: 0.12 kg VOC/1,000 kg product. (96.1% in steam, 40% in air)
VOC REDUCTION PER FACILITY	98% reduction over uncontrolled for a model plant (total plant)
COSTS (for Model Plants) (pp. 5-17, 5-18, 5-19)	Capital Costs ($): Polypropylene 635,900 (TI), 90,600 (F); HDPE 557,400 (TI), 54,500 (F); Polystyrene 28,000 (Steam), 32,300 (Air) Annualized Costs ($/yr): Polypropylene 186,700 (TI), 65,700 (F); HDPE 166,000 (TI), 47,400 (F); Polystyrene -146,700[a] (Steam), 5,660 (Air)

TI= Thermal Incineration
F= Flare

[a] Reflects recovery credit for styrene

TABLE C-27.

SUMMARY OF CTG DOCUMENT FOR VOLATILE ORGANIC COMPOUND EQUIPMENT LEAKS FROM NATURAL GAS/GASOLINE PROCESSING PLANTS

AFFECTED FACILITIES (p. 2-1)	Natural gas/gasoline processing plants, not including compressor stations, dehydration units, sweetening units, field treatment, underground storage facilities, liquified natural gas units, and field gas gathering systems unless they are located at a gas plant.
NUMBER OF AFFECTED FACILITIES	Data not given.
VOC EMISSIONS NATIONWIDE	Data not given.
VOC EMISSION RANGE PER FACILITY (p. 2-11)	Model Plant A (10 vessels) 90 kg/day 32 mg/yr Model Plant B (30 vessels) 270 kg/day 98 mg/yr Model Plant C (100 vessels) 900 kg/day 320 mg/yr
CTG EMISSION LIMIT (p. 4-5)	Plant A: 9.0 mg/yr, 72% Plant B: 27 mg/yr, 72% Plant C: 90 mg/yr, 72%
VOC REDUCTION PER FACILITY	Same as CTG emission limit above.

COSTS (in thousands of June, 1980 dollars)	Model Plant A	Model Plant B	Model Plant C
Total Annualized Cost Before Credit	9.8	18	48
Recovery Credits	-6.5	-20	-65
Net Cost	3.3	-2.0[a]	-17[a]
Cost ($/MG) Effectiveness	140	-28	-74

[a] Recovery credit is larger than annualized cost.

TABLE C-28.

SUMMARY OF CTG DOCUMENT FOR VOLATILE ORGANIC LEAKS FROM SYNTHETIC ORGANIC CHEMICAL AND POLYMER MANUFACTURING EQUIPMENT

AFFECTED FACILITIES (p. 2-1)	Equipment in process units which produce synthetic organic chemicals and polymers (polyethylene, polypropylene, and polystyrene).
NUMBER OF AFFECTED FACILITIES	Data not given.
VOC EMISSIONS NATIONWIDE	Data not given.
VOC EMISSION RANGE PER FACILITY (p. 2-11)	For three model units with varying complexity, uncontrolled emission estimates are: A - 39 mg/yr B - 151 mg/yr C - 470 mg/yr
100 TON/YR SOURCE SITE	The complexity of the facility (i.e., number of valves flanges, etc.) is at least equally as important as the size in determining emission levels. Totals of types of sources multiplied by the emission factors for that equipment (p. 2-21) will identify 100 ton/yr sources.
CTG EMISSION LIMIT (p. 5-10)	Percent reduction in all model units is 36% under RACT
VOC REDUCTION PER FACILITY	Same as CTG emission limit above.
COSTS (pp. 5-11, 5-12)	Costs per model plant are balanced below with recovery at product.

Model Plant	Initial[a] Costs	Recovery[b] Credits	Annualized[b] Cost	Cost Effectiveness
A	$15,900	$6,200	$5,600	$370/mg
B	$35,800	$24,000	$4,300	$77/mg
C	$91,200	$74,000	$2,300	$13/mg

(a) One time cost.
(b) Annualized credit/cost.

TABLE C-29.

SUMMARY OF CTG DOCUMENT FOR THE AIR OXIDATION PROCESS IN SYNTHETIC ORGANIC CHEMICAL MANUFACTURING INDUSTRY

AFFECTED FACILITIES (p. 2-1)	Those facilities that produce chemicals included in the synthetic organic chemical manufacturing industry by reacting more chemicals with oxygen, ammonia, or halogens, and air.
NUMBER OF AFFECTED FACILITIES (pp. 2-3, 2-18)	There are 161 facilities operated under 59 companies which produce one or more of the 36 air oxidation chemicals.
VOC EMISSIONS NATIONWIDE	40,390 mg/yr (p. 4-3).
VOC EMISSION RANGE[a] PER FACILITY	0.0205 kg/hr - 2150 kg/hr.
100 TON/YR SOURCE SIZE	Data not given.
CTG EMISSION LIMIT (p. 4-5)	Average plant emissions for facilities required to control VOC = 31.2 mg/yr. Average plant emissions for facilities not required to control VOC = 560 mg/yr.
VOC REDUCTION PER FACILITY	Thermal oxidation - 98% for facilities with controls; 53% above baseline for total VOC. Only 14 of 47 plants in nonattainment zones would control VOC emissions under RACT.
COST EFFECTIVENESS (p. 5-24)	$1600/mg[b] VOC controlled.

[a] Figures are from the 59 facilities for which data is represented.

[b] June, 1980 dollars.

APPENDIX D - EXAMPLE QUESTIONNAIRES

A general discussion of the design and use of questionnaires is presented in Chapter 3. This appendix contains example questionnaires for inventorying VOC emissions from solvent use. The inclusion of these questionnaires does not imply an endorsement by EPA or a requirement to use them. They are presented merely to show basic structure, possible content, and various alternatives available.

Additional example questionnaires and background discussion on questionnaire development are available in Reference 1. These questionnaires are also not required or endorsed by EPA. The reader is simply referred to the document for additional information.

The primary consideration in developing questionnaires is the inventory agency's data requirements. The agency's needs will determine whether to use general or industry-specific questionnaires and what data to elicit. Discussion on general versus industry-specific questionnaires is included in both Chapter 3 and Reference 1.

The reader is reminded to observe several caveats when reviewing the questionnaires in this Appendix. Note that industry-specific questionnaires must be developed for refineries, chemical manufacturers, and some other sources. For a VOC emissions inventory, each questionnaire design should be consistent with the data requirements of emission factors in AP-42, CTG documents, or any other references. These references should be reviewed during the development of questionnaires. In addition, local or state regulations should be consulted before mailing questionnaires to ensure that all clearance requirements for the forms are met. For example, EPA questionnaire forms must be approved by the Office of Management and Budget prior to release to more than ten sources. Finally, the reader is reminded to note the caveats mentioned in Chapter 3.

Reference for Appendix D

1. Development of Questionnaires for Various Emission Inventory Uses, EPA-450/3-78-122, U.S. Environmental Protection Agency, Research Triangle Park, NC, June 1979.

[Agency Letterhead]

Mailing
Label

Dear Madam(s) and/or Sir(s):

The (agency or department) requests your cooperation in providing the information described on the enclosed questionnaire. The data provided will be evaluated along with information being gathered from other sources to determine the impact of hydrocarbon, nitrogen oxide, and carbon monoxide emissions on the air quality in (geographical area). This request is being made under (statute) which allows information to be required from sources of air pollution. In addition, the more nearly complete and accurate the response to the questionnaire, the more valid the conclusions of the study will be.

Certain emission-related data on your equipment or processes have been extracted from available records. The information requested on the enclosed forms is not available from current agency records and is needed to assess baseline emissions and control potential, and to project future emissions. Please complete the enclosed questionnaire and return it within (time period) to the address indicated on the form.

Any questions regarding these forms should be directed to

(name, address, phone number)

Your cooperation in providing the requested information within (number) days from receipt of this letter will contribute materially to the accurate assessment of emissions in (area). Thank you for your assistance.

Sincerely,

(name and title)

Enclosures

Figure D-1. Example cover letter.

GENERAL INSTRUCTIONS

ORGANIC SOLVENT SOURCE QUESTIONNAIRE

1. All questions should be directed to (name, address, phone number)

2. This questionnaire is aimed at obtaining information from a wide variety of solvent users. The complete questionnaire includes the following pages:

   Page A - GENERAL INFORMATION
   B - DEGREASING OPERATIONS
   C - DRY CLEANING OPERATIONS
   D - PROTECTIVE OR DECORATIVE COATINGS
   E - FABRIC OR RUBBERIZED COATINGS
   F - MISCELLANEOUS SURFACE COATINGS
   G - OVENS
   H - PRINTING
   I - GENERAL SOLVENT USE
   J - BULK SOLVENT STORAGE
   K - CONTROL AND STACK INFORMATION

3. Annual or average summer day data should reflect average operating data for the period from ___ to ___.

4. Fill in the descriptive information and amount of solvent or solvent containing materials used for each device operating under county permits as shown in the example on each page. (Note: these examples are for illustration only and may not represent actual operating conditions.)

5. In the event that data are not available on an individual device basis, use best estimates from total plant usage to complete Item 4.

6. If the type(s) and/or percentages of solvents in coatings, inks, etc. are not known, include sufficient information on the manufacturer, type, and stock number so that this breakdown can be obtained. A copy of a supplier's invoice would be adequate.

7. Complete Pages I, J and K.

8. The emissions data that will be generated during this program will generally be public information. If certain process, operation, or material information is considered confidential and should be considered a trade secret, indicate such (specify a procedure and specify how confidential data will be handled).

Figure D-2. Example questionnaire - Instruction sheet.

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ORGANIC COMPOUND EMISSIONS QUESTIONNAIRE

Mail Questionnaires in the Enclosed Envelope To:

Please Address All Questions To:

NOTE: ALL DATA SHOULD REPRESENT CALENDAR YEAR

GENERAL INFORMATION

Company Name _____

Plant Address _____ City _____ Zip _____

Mailing Address _____ City _____ Zip _____

Person to Contact About Form _____

Telephone _____ Title _____

Approximate Number of Employees _____

Nature of Business (Include SIC) _____

_____

Normal Operating Schedule for Calendar Year _____

_____ Hrs/Day _____ Days/Week _____ Weeks/Year

Approximate Percent Seasonal Operation:

Dec.-Feb.	Mar.-May	June-Aug.	Sept.-Nov.

Are hydrocarbon or organic solvent containing materials such as cleaning fluids, coatings, adhesives, inks, etc. used in your operation?

_____ Yes _____ No If yes, please complete the appropriate forms enclosed. Make additional copies if necessary. If organic solvents are not in use please sign and return.

_____ Signature

_____ Date

Figure D-3. Example questionnaire - General information page.

DEGREASING OPERATIONS

1. Materials Processed _____

2. Type and Amount of Solvents Used:

County Permit Number	Type of Degreasing*	Type(s) of Solvents Employed†	Amount of Solvents Added (Gal/Yr)	Amount of Solvent Removed for Reprocessing (Gal/Yr)	Normal§ Operating Hr	Day	Week
EXAMPLE		Perc	2000	500			
P99999	Vapor				8	5	50

*Cold cleaning, vapor degreasing

†Stoddard, 1,1,1, trichloroethane, perchloroethylene, methyl chloride, trichloroethylene, other (specify.)

§Normal operating period - hrs/day, days/wk, and wk/yr. If the approximate percent seasonal operation differs from that on Page A, please indicate.

Figure D-4. Example questionnaire - Degreasing operations form.

DRY CLEANING

1. Material Being Cleaned: _____

2. Type and Amount of Cleaning:

County Permit Number	Amount of Clothes Cleaned (Tons/Yr)	Type of Cleaning*	Type(s) of Cleaning Solvents†	Amount (Gal/Yr)	Normal§ Operating Hr	Day	Week
EXAMPLE P99999	2000	Hot	Perc	2000	8	5	50

*Hot unit (washing/extraction/drying in one machine) or transfer unit (use of a separate recovery tumbler)

†Perchloroethylene, Stoddard, other (specify)

§Normal operating period - hrs/day, days/wk, and wk/yr. If the approximate percent seasonal operation differs from that on Page A, please indicate.

Figure D-5. Example questionnaire - Dry cleaning form.

PROTECTIVE OR DECORATING COATINGS

1. Materials Coated _____

2. Type and Amount of Coating Used:

County Permit Number	Application Method*	Type of Coating†	Amount of Coating (Gal/Yr)	Type and % of Major Solvents		Type and Amount of Solvents Added (Gal/yr)		Method of Drying-(Air, Heat Treated)	Normal Operating§ Hr/Day	Day/Week	Week/Yr
EXAMPLE				MEK	60 %	Toluene	200	Oven			
P99999	Spray	Enamel	2000						8	5	50

3. Type of Cleaning Solvent: _____, Amount _____ (Gal/Yr)

*Spray, dip, roller, flow, etc.

†Paint, varnish/shellac, lacquer, enamel, primer

§Acetone, Isopropyl alcohol, MEK, butyl acetate, cellusolve, toluene, other (specify)

*Normal operating period - hrs/day, days/wk, and wk/yr. If the approximate percent seasonal operational differs from that on Page A, please indicate.

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Figure D-6. Example questionnaire - Protective or decorative coatings form.

FABRIC OR RUBBERIZED COATING APPLICATION

1. Materials Coated _____

2. Type and Amount of Coating Used:

County Permit Number	Application Method*	Type of Coating†	Amount of Coating (Gal/Yr)	Type and % of Major Solvents		Type and Amount of Solvents Added (Gal/Yr)		Method of Drying- (Air, Heat Treated)	Normal Operating§ Hr	Day	Week
EXAMPLE				Toluene	60%	Toluene	200	Air			
P99999	Lamination	PVC	1000	Xylene	40%				8	5	50

3. Type of Cleaning Solvent _____, Amount _____Gal/Yr

*Impregnation, "wet" coating, hot melt coating, lamination

†Polyvinyl chloride, polyurethanes, etc.

‡Toluene, naptha, mineral spirits, MEK, xylene, chlorinated hydrocarbon, other (specify)

§Normal operating period - hrs/day, days/wk, wks/yr. *If the approximate percent seasonal operation differs from that given on Page A, please indicate.

Figure D-7. Example questionnaire - Fabric or rubberized coatings form.

MISCELLANEOUS SURFACE COATING APPLICATION
(ADHESIVES, PAPER, LEATHER, FILM, GLASS, ETC.)

1. Materials Coated _____

2. Type and Amount of Coating Used:

County Permit Number	Application Method*	Type of Coating†	Amount of Coating (Gal/Yr)	Type and % of Major Solvents		Type and Amount of Solvents Added (Gal/yr)		Method of Drying- (Air, Heat Treated)	Normal Operating§ Hr	Day	Week
EXAMPLE				Toluene	60%	Toluene	200				
P99999	Spray	Adhesive	1000	MEK	40%			Air	8	5	50

3. Type of Cleaning Solvent _____ Amount _____ (Gal

*Spray, flow, dip, roller, brush, etc.

†Adhesive type, pigment coating, barrier coating, polymeric coating, inorganic coating, etc., (specify)

‡Branched alcohol, linear alcohol, ethyl acetate, toluene, xylene, ethers, MEK, naptha, other (specify)

§1975 normal operating period - hrs/day, days/wk, and wk/yr. If the approximate percent seasonal operation differs from that given on Page A, please indicate.

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Figure D-8. Example questionnaire - Miscellaneous surface coating application form.

OVENS AND OTHER HEATED EQUIPMENT
(INCLUDE HEATED DEVICES WITH INTEGRAL
OVENS ALREADY REPORTED ON OTHER FORMS)

1. Material Being Dried _____

2. Operational Data:

County Permit Number	Operation*	Heating Method†	Heater Rating (Btu/hr) and Temp (°F)	Permit Numbers of Spray Booth(s) or Coater(s) Feeding Oven	Normal Operating§ Hr	Day	Week
EXAMPLE P99999	Batch	Gas (IF)	10,000 700 °F	P99998 P99997	8	5	50

*Batch or continuous

†Electric, steam, waste heat or gas. If gas fired, specify: Indirect-Fired (IF) products of combustion not mixed with oven gases. Direct-Fired Fresh Makeup (DFFM) products of combustion mixed with oven gases. Direct-Fired Recirculation (DFR) oven gases used as combustion air supply.

§Normal operating period.

Figure D-9. Example questionnaire - Ovens and heating equipment form.

PRINTING

1. Material Being Coated _____

2. Type of Printing Process and Amounts of Solvents Used:

County Permit Number	Printing Process*	Type of Ink†	Amount (Gal/Yr)	Type and % Major Solvents In Ink‡		Type and Amounts of Solvents Added (Gal/Yr)§		Normal Operating¶ Hr	Day	Week
EXAMPLE				Isopropanol	70	MEK	100	8	5	50
P99999	Flexigraphic	Alcohol Solvent Based	2000	Methanol	15					
				Ethanol	15					

3. Type & Amount Cleaning Solvent Used _____ Amount _____ Gal/Yr

*Letterpress, flexographic, lithographic, gravure, screen

†Solvent based, oil based, lacquer type, etc.

‡Isopropyl alcohol, ethanol, propanol, naptha/mineral spirits, toluene, MEK, other (specify)

¶Normal operating period - hrs/day, days/wk, wks/yr. If the approximate percent seasonal operation differs from that given on Page A, please indicate.

Figure D-10. Example questionnaire - Printing form.

GENERAL SOLVENT USAGE

Type and amount of other solvents not identified with equipment having a county permit that were used at your facility during calendar year

Do not include any solvents that have been included elsewhere in this questionnaire.

TYPE	AMOUNT (GAL/YR)

SOLVENT RETURNED

List any solvents returned to supplier or collected for reprocessing. Again, do not include any solvents that have been so specified elsewhere in this questionnaire.

TYPE	AMOUNT (GAL/HR)

Figure D-11. Example questionnaire - General solvent usage form.

BULK SOLVENT STORAGE

Complete the following information for each storage tank greater than 250 gallons capacity. (See Editorial Note below)

Tank No.	Solvent Type	Capacity	Annual Thruput	Type of Fill and Control Equipment*

* Submerged fill, splash fill, return vent line, adsorber.

OPERATIONAL MODIFICATIONS

Please state the changes in type and estimated annual consumption of solvent planned for all operations for calendar years Include any information on control equipment additions or modifications:

(Editorial Note: This questionnaire should contain space for two additional pieces of information: tank color and tank condition. The reader is reminded that these questionnaires are provided as examples and not as recommended procedures.)

Figure D-12. Example questionnaire - Bulk solvent storage form.

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CONTROL AND STACK INFORMATION

INSTRUCTIONS:

1. Provide information on all devices that emit organic compounds through a stack, vent or other defined emission point. Identify all units under separate permits that vent through a common stack. A simple drawing may be provided to better illustrate the physical configuration.
2. Identify the primary organic compound control method used (if any) such as after burners, scrubbers, carbon adsorption, condensers, etc. Note: this device may have its own permit number. If so, identify.
3. Indicate installation date of control equipment.
4. Indicate approximate efficiency (if known).
5. Provide the following information:

   Height - distance above ground to discharge point (feet)
   Diameter - inside diameter at discharge point (feet)
   Note: if not circular, insert diameter (in feet) of equivalent circular area which can be calculated by

   $$D_e = 1.128 \sqrt{A}$$

   where A is the measured or estimated cross-sectional area in sq ft and D_e is the equivalent diameter.
   Temperature - at discharge point in °F
   Velocity - at discharge point in ft/sec
   Flow rate - at discharge in actual cubic feet per minute (ACFM)

Design conditions may be used in lieu of actual test data.

County Permit Number	HC Control Eqmt	Control Eqmt Effic. (%)	Installation Date	Stack Data				
				Height (ft)	Inside Dia. (ft)	Temp (°F)	Velocity (ft/sec)	Flow Rate (ft^3/min)
EXAMPLE	After-burner	95	1969	20	1.5	600	20	2100

Figure D-13. Example questionnaire - Control and stack information form.